THE

ELECTRICAL REVIEW.

VOL. XXXVI. MAY 3, 1895. No. 910.

CONTENTS:

	PAGE
Bye Uses of Electrical Energy	525
The First Three-Wire Lighting Plant (*illustrated*)	527
The Scientific Uses of Liquid Air (*illustrated*)	529
The Use of Electricity for Heating and Cooking.—II. (*illustrated*)	531
Alternating and Interrupted Electric Currents.—II.	533
Correspondence:—	
Lightning and the St. Pancras Explosions	533
Arc Lamp Standards	534
Gas *v.* Steam Engines	534
An Interesting Question	534
Kingdon System of Electric Light Mains	534
Legal:—Shelfer *v.* City of London Electric Lighting Company	534
Whiffen and Others *v.* The Crompton Electric Supply Company of Australia	534
New Zealand Electrical Syndicate	535
The Planet Electrical Engineering Company	535
Business Notices, &c.	535
Electric Lighting Notes	536
Electric Traction and Motive Power Notes	537
Telegraph and Telephone Notes	538
Contracts Open and Closed	538
Decorative Electric Lighting (*illustrated*)	539
Notes	558
City Notes	561
Traffic Receipts	562
The Telephone Service: Parliamentary Inquiry	563
Tests of Glow Lamps, and Description of the Measuring Instruments Employed (*illustrated*)	565
New Patents	567
Abstracts of Published Specifications	568

THE

UNIVERSAL ELECTRICAL DIRECTORY

(J. A. BERLY'S).

PRICE 4/- POST FREE. The Leading Electrical Trades Directory *and the Oldest Electrical Directory in the World.*

1895 ISSUE READY.

PRICE 4/- POST FREE. Fully Revised and Thoroughly Reliable. *Contains a larger amount of Trade Matter than any other Electrical Directory.*

H. ALABASTER, GATEHOUSE & CO.,

22, Paternoster Row, London, E.C.

THE ELECTRICAL REVIEW.

Published every FRIDAY, Price 4d.

The Oldest Weekly Electrical Paper. Established 1872.

TO BE OBTAINED BY ORDER FROM ANY NEWSAGENT IN TOWN OR COUNTRY.

OFFICE:—22, PATERNOSTER ROW, LONDON.

Telegraphic Address: "AGENCY, LONDON." Code A B C. Telephone No. 517.

ALL Letters should be addressed to the Proprietors, H. Alabaster, Gatehouse & Co.

ADVERTISEMENT RATES ON APPLICATION.

The "Electrical Review" is the recognised medium of the Electrical Trades.

SUBSCRIPTION RATES.—In *Great Britain*, Post Free per Year, 19s. 6d. To all *other Countries*, per Year, £1 4s.

BINDING.—Subscribers' numbers bound, including case, for 4s. each volume.

CASES.—Cloth Cases for Binding can be had, price 2s. 6d. each.

FOREIGN AGENTS.—New York: D. VAN NOSTRAND, 23, Murray Street. *Paris:* VEUVE J. BOYVEAU, 22, Rue de la Banque. *Berlin:* ASHER & Co., 5, Unter den Linden.

Cheques and Postal Orders (on Chief Office, London) to be made payable to Mr H. ALABASTER, 22, Paternoster Row, E.C.

BYE USES OF ELECTRICAL ENERGY.

A COUPLE of years ago we devoted some attention to the effect which an increase of the day load would have upon the efficiency of central station supply, using this term in the ultimate and financial sense in which it really affects the value of a business concern. That is to say, the ratio of the actual monetary return which a given capital outlay will yield to the maximum return that same capital would give at the regular market rate of interest. Since that time many developments have taken place, but the facts have not altered, except in so far as thermal storage and other items of engineering economy may modify some of the conditions under which the central station engineer labours. The day load factor and the annual load factor have been objects of discussion ever since the time we wrote, as they were at that time. It is now quite common ground with electrical engineers that an improvement in the annual load factor may be expected to follow the sale of current for bye uses of electricity. Amongst the methods cited by which such improvement is to be effected, is the use of storage tramcars as being best suited to replace existing horse tramcars where the gradients permit, the application of electricity to sewage disposal, the present tendency to combine refuse destructors and lighting stations, the economy of electric motors, and the application of electricity to various arts, such as bleaching, electrotyping, and metallurgical purposes. Mr. Crompton's Society of Arts paper brings forward electric heating as an advantageous employment of electrical energy. In his own words, we "have been told that the cost of electrical supply may be greatly reduced if it can be utilised during the daytime for other purposes in addition to lighting." This refers to the day load factor, and suggests a hope that the domestic uses of electricity will assist to fill up the valley of the load curve.

Taking this suggestion as a theme, we might repeat much of what has been said for and against the proposal, from an electrical engineer's point of view. No one doubts, nowadays, the many advantages of electrical cooking utensils compared with those used with solid or gaseous fuel. At least, if such there be, a little practical experience would prove very convincing, but the question is not so much the benefits derived by the consumer, as the advantages which will accrue to the suppliers of electricity. These, we think, have been overrated. The direct incidence of an increased use of domestic appliances of the nature of electric kettles, ovens, and so forth, will be to extend and develop the business of supply rather than to flatten the load curve. In this matter, the direct benefit must be comparatively small; it only requires a little thought to see that the valley to be filled up is so deep that it would require a very general use of electricity for culinary operations to do much in this

desirable direction. At the same time, the public attention has "caught on" to the idea of heat without flame, and as the devices to which electrical heating is applied increase in number, so must their sale rise in proportion. On the principle that every little helps, the current taken by every one of them will go to swell the consumer's bill. He will gain by the use of cleanly and readily controlled devices in place of many which are directly the reverse, while the supply stations will sell more units, and profit accordingly. There is, therefore, little probability of electric cooking and heating sinking into comparative insignificance, as has been prophesied by "some who ought to know better," to use Mr. Binswanger's phrase. "All who are desirous of seeing the scope of the electrical industry extended must be thankful" to those who have pioneered this movement. Not less thankful should the public be for the benefits they must derive eventually. But it is noteworthy that neither Mr. Crompton nor any other speaker at the Society of Arts held out great hopes of a large improvement in the load factor due to this cause. Great stress was laid upon the advantages and utilitarian aspect of the question, and on these points we can give an unqualified assent. Until electric cookers can be made and sold at not more than double the present cost of coal and gas heated appliances, the great mass of the people will not be tempted to adopt electricity by a reduced rate per unit. And it must not be forgotten that every inroad made by electric lighting upon the preserves of the gas companies will cause them to make more and more strenuous efforts to enlarge their *clientèle* by pushing gas cookers. No doubt the gas fraternity think it very hard that after being told that gas is only good for heating and that electricity is the future means of lighting, electrical engineers should step in and claim the domain of heating and cooking also. The rich and well-to-do may have their ovens, hot plates, and radiators heated by resistance wires and even the post offices melt their sealing-wax in the same way, but the great middle class are more likely to content themselves with gas, which is after all not so very far behind electricity in convenience or in cost. When either the cost of electrical supply or the price of electrical cooking appliances shows a marked change from those at present ruling, then another complexion may be put upon the question.

Equalising the Load.

IT is repeating a truism to say that the cost of electric light will be reduced to one-half or a third of its present price when the demand for the electric current is such as will enable the machinery at the central station to be worked continuously at its full capacity. This ideal result has been partly realised in one case in Germany by shifting over the engines of the central station to the pumping engines of the waterworks, when they are not required for the dynamos. The objection to this, however, is that the electrical part of the plant is not fully employed. The suggestion has also been made to create a motor load to supplement the lighting load, by supplying electric energy during the day at lower rates; but in this scheme also there is the defect that the motor load overlaps the lighting load to such an extent that there is very little reduction in the ratio of the maximum to the average load. Mr. N. W. Perry points out in an article in *Electric Power* that some of the many new industries that have been created by the production of cheaper electric energy for lighting, may yet work out the salvation of the parent to whom they owe their existence, by filling up the gaps in the central station lighting load. Among the industries mentioned as well adapted to create the supplementary load required, are Hermite's bleaching process, the production of disinfecting fluids for flushing sewers and other municipal cleansing processes, and electro-metallurgical processes, such as the production of aluminium or the purification of copper. These are all well established and successful examples of the application of electric energy, and their supply with current would be to a great extent under the control of the central station engineer. Wherever it is possible to create a supplementary load by the supply of these industries, it will undoubtedly cheapen the production of electric light, but we fear there will always be a large proportion of central stations situated in localities where such industries cannot be profitably carried on.

Corporations *v.* Private Firms.

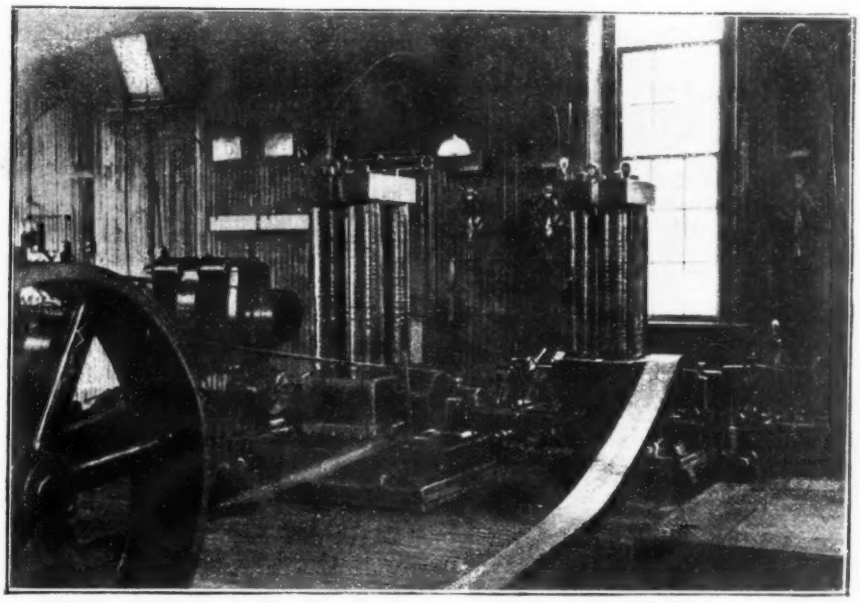
IN our description of the Leicester Corporation's Central Electric Light Station last week, we briefly alluded to the fact that in connection with this work there has been organised an electric light fitting department, the result of which has been that the greater portion of the wiring and fitting in the town has been carried out by the Corporation. This action has caused much indignation amongst the local electrical firms, which is scarcely to be wondered at, considering that the Corporation is competing against its own ratepayers. If the Corporation simply let out fittings on hire and gave the installing of them and also the wiring to contractors, there would be little to grumble at; but to undertake the wiring and fitting of private premises which should be carried out by business firms either in Leicester or elsewhere is a proceeding which seems to us most unjust, even if it is not absolutely illegal. It is said that the profit on the fitting department is going towards the loss on the present supply of current, but surely this reason for the very injudicious step taken by the Corporation is too ignoble to be taken seriously, especially as it is further stated that the Corporation is supplying and fixing private plants in addition to installations on the town mains. The tests and safeguards enforced in electric wiring are so stringent, that it is difficult to imagine the work of private contractors would be inferior to that of the Corporation, so if there is any truth in the allegations that the Corporation officials are said to make with regard to the inferior workmanship of private firms, there is still further ground for grave complaint. We would suggest that the aggrieved tradesmen should procure a copy of the Leicester Provisional Electric Lighting Order, so as to ascertain if the Corporation is legally entitled by it to compete with its own townsfolk; even if it is so, the course now pursued is impolitic, and little short of iniquitous.

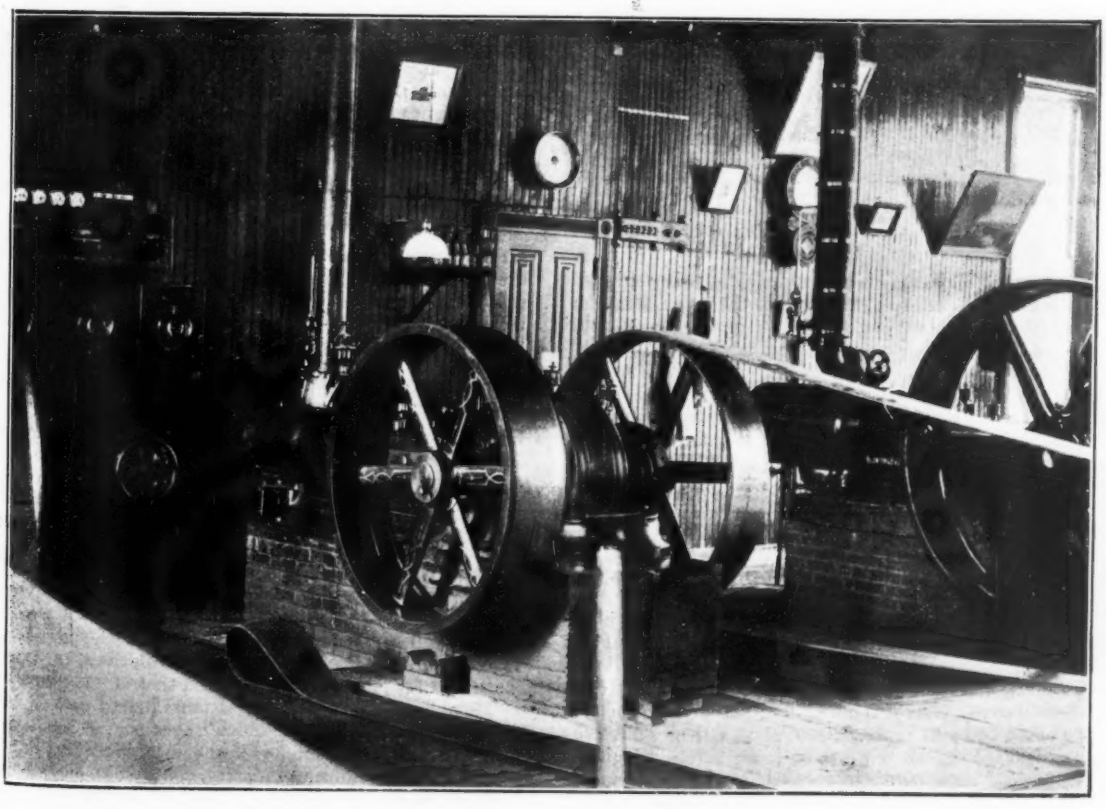
Expression for Electro-magnetic Force.

MESSRS. C. T. HUTCHINSON and E. R. Carichoff in a recent issue of the *Electrical World*, contribute a new and decidedly useful method of deducing the expression for electro-magnetic force due to a current in a conductor. Starting from Biot and Savart and Maxwell's experimental proof that the force, F, due to a current, C, in an unlimited rectilinear conductor on a pole of unit strength, at distance r, is $\frac{C}{r} \cdot K$, where K is a constant such that the expression for work done may be equal to N C, N being the number of lines cut by a conductor. Then, assuming the unlimited rectilinear conductor to revolve completely around the unit pole as centre, so as to cut the 4π lines once, the constant, K, is easily deduced as $\frac{1}{2}$. The force due to the current in the rectilinear conductor is thus $F = \frac{C}{2r}$, and the work done is always $W = N C$. By using this expression to deduce the force inside a long solenoid, the usual cumbrous method is rendered quite unnecessary. A unit pole is supposed to move along inside the solenoid parallel to the axis, a distance equal to, say, $\frac{1}{n}$th part of a centimetre, where n is the number of turns per centimetre length. The whole circuit is thus cut by 4π lines, and $W = 4\pi C$, hence, in this case, $F = W \div \frac{1}{n} = 4\pi n C$

THE FIRST THREE-WIRE LIGHTING PLANT.

During the past summer the writer happened to be in the town of Sunbury, Pa., and a casual visit made to its Edison central station recalled some very interesting historical associations connected with this plant. Sunbury is a beautiful town of 10,000 inhabitants, lying just at the confluence of the two Susquehannas, in the heart of a region whose great natural beauty is enhanced by many weird Indian legends. The present central station, of which Mr. C. J. Callahan is the general manager, is located in a neat little brick building on a spur of the N.C.R. It contains some three pairs of modern Edison dynamos, and two Wood arc machines, all driven by Armington & Sims's engines. But interest centres in the odd looking dynamos belted to a small Armington and Sims engine. They were originally installed in a small frame building in 1883, and later transferred to the present station, having been in continuous use since they were first started.

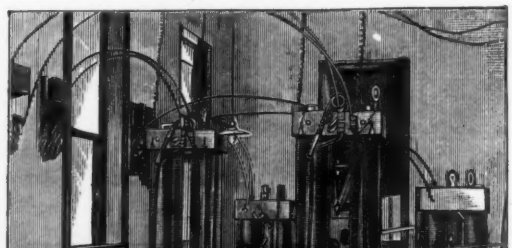




During 1880, the experiments of Mr. Edison at Menlo Park on incandescent lamps and methods of distribution attracted universal attention to artificial lighting in small candle-powers by electricity. During the two succeeding years this interest bore fruit in the installation of a number of isolated plants, conspicuous among these being that of the lighting of the office building of the *New York Herald* in March, 1882.

Immediately following this was the construction and formal opening of the Pearl Street station in New York; the first central station of any consequence. Up to this time the distribution had been on the ordinary two-wire multiple system. The problem which the inventor now took up was the reduction of the amount of copper required as well as the attempt to avoid the great drop of pressure at remote points on the circuit. Early in 1883, Messrs. F. J. Sprague and W. S. Andrews had made experiments for Mr. Edison in a small way at the New York shops of the Edison Company, and succeeded in demonstrating the practicability of distribution on the three-wire system. Their experiments proving so successful, it was at once determined to put the new system to a practical commercial test on a larger scale.

It was just at this time, April 24th, 1883, that the Edison Electric Illuminating Company of Sunbury, Pa., was organised at Williamsport, Pa., with a capital stock of $16,000. On May 7th they closed a contract with Mr. Edison to erect a plant at Sunbury with a capacity of 5,000



16-C.P. lamps. This was an opportunity not to be neglected to put the new system to a crucial test, the town being far removed from the ubiquitous newspaper reporter in case the new system should not prove successful.

On June 4th, Messrs. Sprague & Andrews arrived in Sunbury to superintend the electrical installation. The station was a small wooden structure situated some distance from the business portion of the town, and comprised an engine and dynamo room, boiler room and meter room. The boiler was a Babcock & Wilcox water tube, and the engine an Armington & Sims, to which was belted two of the old type of Edison dynamos. The switchboard instruments consisted of two pressure indicators of ponderous build and uncertain disposition, and one ammeter placed in the neutral 'bus conductor.

When the nature of the installation became known, it excited a great deal of local interest, especially amongst the railroad engineers. When they learned of the high speed and close regulation demanded of an engine to run these dynamos, they were sceptical, and did not believe such an engine could be built. Mr. Edison quieted their doubts by telling them that he knew where he could obtain a suitable engine to meet these requirements. After the station was in successful operation, the engine was even a greater wonder than the dynamos.

Quite a number of the larger buildings in the town contracted for the new light, the largest purchaser being the City Hotel.

Mr. Edison from the first took a large personal share in the enterprise. He spent a considerable time in New York in laying out the plans for the system of conductors, and in designing the arrangement of the electrical machinery and apparatus in the station. After the installation was well under way, a date was set for the formal opening. Mr. Edison had promised to come from New York to start the plant on the evening of July 4th, and patriotism demanded that it should be ready. On the evening of July 3rd an accident to the engine somewhat dampened their hopes, but by unremitting exertion extended through the night, the damage was repaired, the temporary wiring of the little station was completed, and the next evening everything was in readiness for the start.

To use Mr. Andrews's description of the start: "About half an hour before sunset, Mr. Edison gave the word and the engine started, but the dynamos refused to 'wake up,' and mental gloom began to settle down on all of us. 'There's a "bug" in the connection,' remarked Mr. Edison, but no, not a wire was changed. 'Something gone wrong on the pole line, then,' said Mr. Edison, so we all started out on a tour of inspection, and not far from the station found that two sagging feeder wires had crossed. This trouble being remedied, we hurried back as the sun was setting.

"Fortune now smiled upon us, the lamps in the station came steadily up to candle-power, and a general rush was made 'down town' by all hands that could be spared. The City Hotel was the largest wiring job, and we found it radiant with the new light. Expectant excitement had given place to noisy expressions of wonder and delight amongst the townspeople who thronged the hotel, and thus was the first Edison three-wire station started up amidst the firing of cannon and the usual Fourth of July demonstration."

Mr. Edison remained for some days to watch the working of the plant, and to give instructions regarding its operation. The plant thus auspiciously opened has remained in constant operation to the present time.

Many incidents of these early days have a touch of excitement and humour in them. "Not long after the starting of the station, a heavy thunderstorm poured over Sunbury, and at that time no insulating gas fixture joints were in use. The writer happened to be just then in the office of the City Hotel, when, all at once, sharp cracks were heard and bright sparks were seen to shoot from the wires around the gas fixtures. A general stampede ensued into the pouring rain, umbrellas being forgotten in the rush for safety; but the writer succeeded in restoring a measure of public confidence by the innocent fabrication that most likely the wires had saved the hotel from being struck by lightning by carrying off the accumulation of atmospheric electricity to earth through the gas pipes."

The illustration of the dynamos shows the original pressure indicators placed on the station wall, and under them the circuit-closing switches now ordinarily placed on the dynamos themselves. It will be noticed that the dynamos were of the old multi-magnet type. They are 5 feet 3 inches high from the sub-base; they were rated at 140 ampères at 110 volts each, and were of the old Edison "L" type.

The original armatures are still running, and, in fact, no important repairs of any kind have been necessary—a tribute both to conscientious construction and careful management. At the time the writer saw them they were each carrying a load of 125 ampères, and he was told that they have frequently been run on an overload. One peculiarity in the management of the station is seen in the use of water lubrication for the dynamo bearings. A small stream of water is kept constantly passing through the bearings, which have been made watertight. This fact is simply stated, without comment.

The engine is rated at 50 H.P., and is 7½ inches by 9½ inches. It runs at a speed of 325 revolutions per minute. Its record for reliability has equalled that of the dynamos.

This historical sketch seems strange indeed in view of the fact that the time interval which has elapsed is less than 12 years; but it truly epitomises the marvellous development of the electrical lighting industry.

The writer acknowledges his indebtedness to the courtesy of Mr. Edison and his co-labourer, Mr. W. S. Andrews, of Schenectady, New York, for the subject matter of this sketch. Also to Mr. B. E. Greene, publisher of *Electricity*, for permission to use a copyrighted article in this periodical for July 27th, 1892.

THE SCIENTIFIC USES OF LIQUID AIR.

To make a scientific discovery is one thing, to apply it to the arts or industries is distinctly another. It is often much more difficult to realise the scientific and economical bearing of a fact than it is to find it out. Prof. Dewar seems to combine within himself that faculty rarely found in scientific men, namely of knowing what to do with his discoveries when he has made them. This we contend is the highest attainment. A man who simply amasses data and knows not how to deal with them, is in the position of one who possessing the wit to accumulate money is incapable of using or enjoying it.

The acceleration factor of scientific progress is so predominant nowadays, that it would be a work of supererogation to recall Prof. Dewar's discoveries in connection with the liquefaction of air. It is much more instructive to contemplate what he intends to do with it, and to follow him through his proposals for its scientific application. Those who were privileged to listen to him when he lectured on this subject before the Royal Institution, could not fail to be impressed with the importance of this new adjunct to research work. The Institution theatre, however, is not capable of accommodating many, and so we venture to think that many of our readers who were not present will be glad to see a *prècis* of what the professor said.

Speaking generally, the chief scientific use of liquid air consists in the facilities it gives for the study of the properties of matter at temperatures approaching the zero of absolute temperature. For a number of purposes it does not matter whether liquid air or oxygen is employed. Prof. Dewar, who has been working in conjunction with Prof. Fleming, appears to have used these substances almost indiscriminately, and the experiments made have largely partaken of a qualitative character. This, however, was in the nature of things, for investigations on the properties of matter at the temperature of boiling liquid air must necessarily, in the first instance at least, be largely qualitative rather than rigidly quantitative.

So far the experiments which have been carried out seem to point to, if not to warrant, the conclusion that at the zero of absolute temperature all the pure metals would be perfect conductors of electricity. Under such conditions a current of electricity started in a pure metallic circuit would develop no heat and therefore undergo no dissipation. Similarly it may be inferred that there would be no Peltier effect at the zero; in other words, the passage of electricity from one metal to another, would take place without evolution or absorption of heat.

Liquid air is stored in glass vacuum vessels which are either cylindrical or spherical in shape. Hence these vessels can act as lenses. This fact facilitates the examination of the refractive indices of liquid nitrogen and air, and has led to the conclusion that they are respectively for the D-ray, 1·2053 and 1·2062.

For some time Prof. Dewar has projected a series of observations on the thermal capacity of liquid oxygen and nitrogen, but the difficulties inherent to the task has barred the way. He has now succeeded in using these glass vacuum vessels containing liquid gas for the purpose of determining approximately the relative thermal transparency for heat of high refragability. Liquid oxygen appears to be one of the most transparent liquids known in relation to heat. The results obtained, although probably only approximating to the truth, may be regarded as confirmatory of the inferences Tyndall drew as to the relation between gases and liquids as absorbents of radiant heat.

By a beautifully simple device Prof. Dewar succeeds in storing liquid air so that it shows no signs of ebullition, the surface remaining as quiet and still as if it were ordinary water. This is accomplished by silvering the interior and exterior of the vacuum vessels, a little excess of mercury being left, so that, in the act of filling the inner vessel with the liquid air, the metal is deposited as a fine silvery film; but after repeated use all vacuum vessels employed in the storage and manipulation of the liquid deteriorate. Illustrations of the appearance of such vessels are given in figs. 1 and 2. This property is made use of in testing conclusions as to the amount of matter present in certain vacua; the surface of the vessel being cooled by a sponge of liquid air, suppose a globe of the capacity of 1 litre be taken, filled presumably with nothing but the vapour of mercury by boiling under exhaustion and subsequent removal of all excess of liquid. Such a flask ought to contain mercury in the gaseous state that would weigh less than $\frac{1}{10}$th mgm. Now we know by electric deposition that $\frac{1}{10}$th mgm. of gold can be made to cover 1 square cm. of surface with a fine deposit. Considering the general similarity in the properties of mercury and gold, we should therefore anticipate that if all the mercury could be frozen out of the litre flask it would also form a mirror of about 1 square cm. in area. This is exactly what takes place. If, however, two flasks, one larger than the other, are joined together by a tube about 2 mill. in diameter and 50 mill. long, the whole space being

Fig. 1.

Fig. 2.

a Toricellian vacuum (with some excess of mercury), then, on decanting, the mercury may be transferred to the smaller sphere as represented in fig. 3. On applying a liquid air sponge to the surface of the larger sphere the mercury instantly deposits and the application of a second sponge yields no further mercury deposit.

There are cases, however, in which the application of a sponge of liquid air to the surface of a vessel causes no visible deposit, and yet the inference is that something has been condensed. If highly exhausted vacuum tubes con-

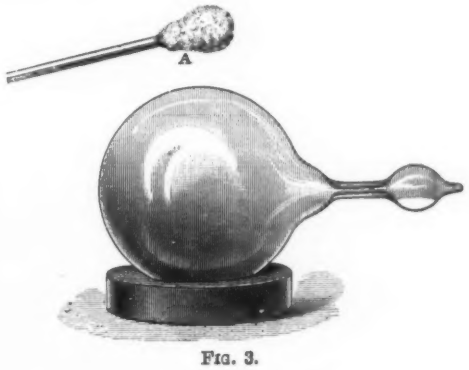


Fig. 3.

taining phosphorescent materials be selected and the induction coil spark gap be arranged of a little greater resistance than the tube, on starting the coil the current passes slowly by the tube, but immediately a portion of the surface is cooled by means of a liquid air sponge the discharge shifts to the air gap. During cooling the phosphorescence is greatly increased, and finally the resistance becomes so great that all discharge in the vacuum tube ceases.

The optical properties of bodies cooled to the temperature of boiling liquid air will require long and patient investigation. But Prof. Dewar has observed the interesting fact that a marked change takes place in their colour. It would seem that the specific absorption of bodies is greatly modified at low temperatures.

Prof. Dewar describes some pleasing experiments with soap bubbles which can be frozen on carefully immersing them in the tranquil atmosphere of air that is superimposed upon the surface of liquid air. The curious and abnormal behaviour of India-rubber can also be illustrated. He has observed, however, that the elasticity of rubber is unimpaired after cooling to − 182° C. and then reheating.

The observations which have been recorded upon organic bodies suggest the inference that the examination of these bodies, at low temperatures, may be a fruitful means of organic investigation.

The difficulty of keeping liquid air without evaporating is one which will occur at once to everyone. This is eliminated by means of the apparatus shown in fig. 4. It is simply two vacuum test-tubes fitting

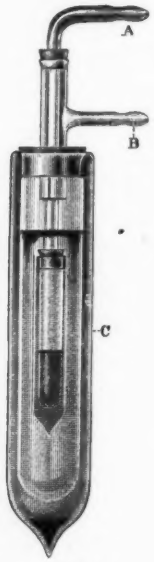


Fig. 4.

freely one inside the other, the smaller being filled with the liquid air, and after insertion of the India-rubber stopper and glass tube it is itself completely immersed in the liquid air contained in the larger vacuum vessel. In the figure the tube, A, connects with the inner vacuum tube, and B with the outer. As the latter receives all the radiant and conducted heat, air is continuously boiling off through the tube, B, but as the supply of heat is effectually cut off from the inner vacuum vessel also containing liquid air, no air distils through tube, A. By this arrangement solid air can be produced with the aid of an air pump to reduce pressure. Solid air is a transparent jelly-like mass.

To determine latent and specific heats, the apparatus shown in fig. 5 is used. In a latent heat determination, all that is necessary is to weigh the mercury, A, which is added for the purpose of supplying a given quantity of heat, and to measure the amount of air by volume which is distilled from C (which contains the liquid air) and passes through the three-way cock, D, into F, where it is collected. E, is a barometric tube for observing the pressure when the inner vessel is exhausted.

If the specific heat is wanted, then the inner vessel is exhausted as well as the outer, through F, to about ½ inch pressure, and the cock, D, turned so as to shut off F and connect the inner vessel with the manometer, E. Mercury is now dropped into the inner vessel till the manometer rises to the atmospheric pressure, as the liquid reaches its boiling point under this pressure. The amount of mercury added conveys the necessary amount of heat to raise the liquid from its boiling point under ½ inch pressure, to that under 30 inches. The relative pressures give the temperature range, and the weight of the liquid air and of the added mercury is easily calculated.

Seeing that the most powerful chemical affinities are in abeyance at very low temperatures, it is a matter of interest to ascertain what change comes over the physical force we name cohesion. If we accept the theory of matter which regards finite heterogeneousness of the most homogeneous bodies as proved, then Lord Kelvin has shown that gravitation alone will account for the so-called cohesive forces: and another view has been formed by Mr. S. T. Preston, which has attracted much attention. The experimental facts, however, do not support it. Hence we may assume for the present that Lord Kelvin's view is the correct one.

At the temperatures reached by Prof. Dewar, the Young modulus is increased to between four and five times its amount at normal temperatures. In the same way the rigidity-modulus has been shown to be greatly changed. In fig. 6 is shown the general plan of the part of the testing machine which support the wires which are broken when determining the tenacity or breaking stress of metals. Gallons of liquid air are required for this experiment. In

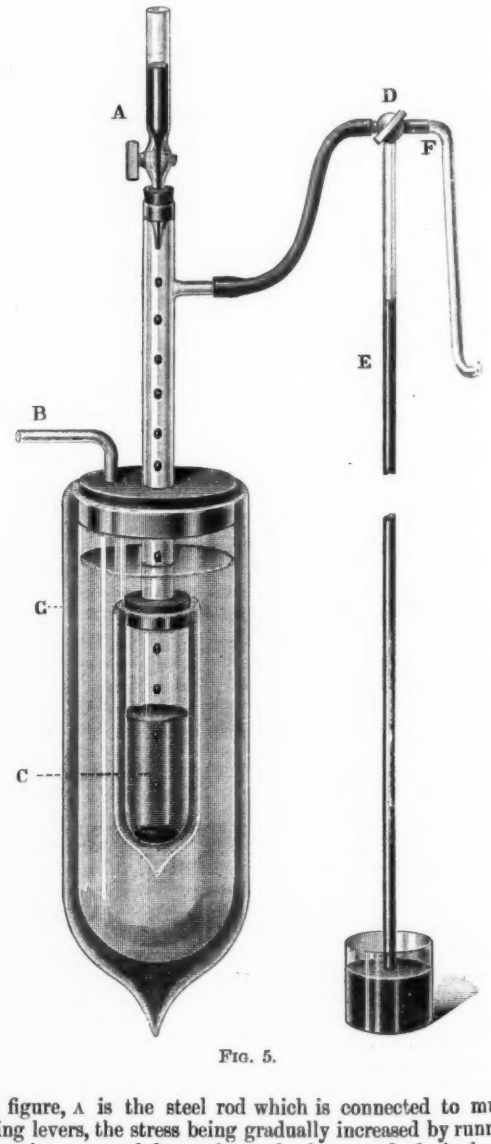


Fig. 5.

the figure, A is the steel rod which is connected to multiplying levers, the stress being gradually increased by running water into a vessel hung from the lower end of the lever; C is the wire to be tested; B is an arrangement which measures the extension of the wire; and D is the silvered vacuum vessel holding the liquid gas. By means of this apparatus all the common metals and alloys have been shown to increase in tenacity at low temperatures.

The examination of the magnetic condition of matter at low temperatures is a subject of great interest, and offers a wide field of investigation. This Prof. Dewar is doing his utmost to explore. The work of Faraday and of Profs. Hopkinson, Trowbridge, and Ewing in this direction is well known. Prof. Dewar has undertaken a series of experiments on the magnetic moment of small magnets cooled to − 182° C. From these experiments it appears that every

magnet has individual characteristics that may either result in no change on cooling or the addition or subtraction of from 12 to 24 per cent. But the experiments show that a repetition of the cycle of heating and cooling *brings the magnet to a steady state*, in which cooling always causes increase in the magnetic strength of from 30 to 50 per cent. and the reheating brings about no loss in the original magnetic moment. As Prof. Dewar points out, such a

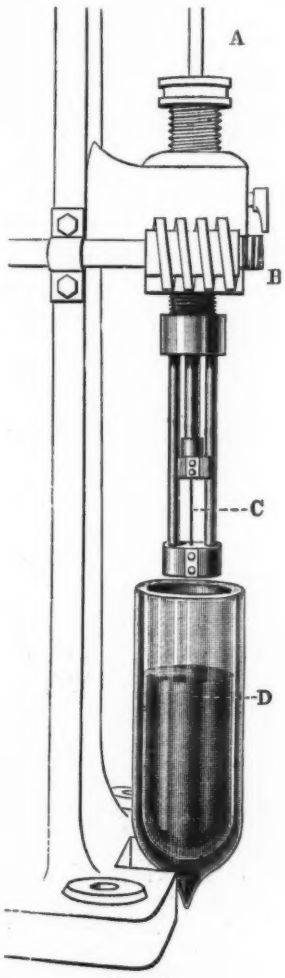


Fig. 6.

marked alteration of magnetic strength might be used as a thermometer in low temperature research, and it is his intention to extend the inquiry to the lowest temperature that can be reached by the evaporation of nitrogen *in vacuo*. He also proposes to make accurate observations on the permeability and susceptibility of the magnetic metals at the temperature of boiling liquid air, and there is every reason to believe that the investigation will be fruitful in new scientific facts.

THE USE OF ELECTRICITY FOR HEATING AND COOKING.

Mr. Crompton stated the object of his paper was to show that heating and cooking by electricity is neither impracticable nor too costly to be seriously adopted. Rather it has now advanced to a highly practical and useful stage. Siemens, Cowles, Lane-Fox, and Carpenter, may be hailed as the pioneers of the movement which has now been brought to a high degree of perfection by Crompton and Binswanger. The paper dealt largely with the methods adopted by Messrs. Crompton & Co., Limited, in the manufacture of domestic appliances. Nickel steel alloys are used for the current carrying wire, and this is embedded in a composite enamel, the base of which is silica. The wire is waved or crimped by a special machine, which serves it on to the surface of a transfer plate, the wire being held on this by means of electromagnets underneath. It is then transferred to the surface of the first layer of enamel, which is of a most refractory character, and has been raised to a temperature sufficient to soften but not to melt it. The wire and first layer is then covered with a second coating of a more readily fusible enamel, after which the whole is raised to such a temperature that the second enamel melts and incorporates itself with the lower layer and with the wire, forming an insulating and air-tight covering, little liable to crack.

It is interesting to see what thermal results are obtained in electric heating operations. Mr. Crompton dwelt upon the high efficiency obtained as compared with other methods, but very little was said as to the absolute efficiency. In Mr. Ward Leonard's table of "Useful equivalents for electric heating problems," he gives 2,656,400 foot-pounds and 3,440 heat units (B.T.U.) as being the equivalents of 1 kilowatt-hour (B.O.T.). Taking 746 watts to the electrical horse-power, the foot-pounds per B.O.T. must be

$$1{,}000 \times 33{,}000 \times 60 \div 746.$$

Working this out by seven figure logarithms, we get 2,654,150 foot-pounds as the work equivalent, the last five being open to question. Taking the more recent figure of 778 as being the value for Joule's equivalent, we find the heat factor for a B.O.T. unit as 3,411·55, the last figure being again doubtful; 3,411 is, however, near enough. For some time we have used 3,438 B.T.U. as the heat factor per kilowatt hour, and even this is lower slightly than Mr. Ward Leonard's figure, and is certainly too high, judged by the foregoing. Now Mr. Crompton gives the following results obtained by his electric kettles:—

A. Tea-table kettle, 1 lb. of water, 50° F. to 212° F. in 18 minutes. Energy consumed ·075 B.O.T.

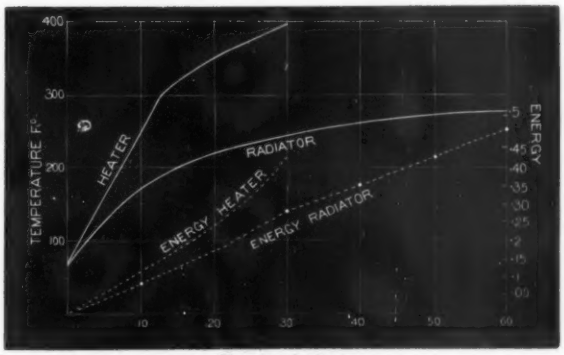
B. Smaller kettle, ¾-lb. of water, 50° F. to 212° F. in 12 minutes. Energy consumed ·051 B.O.T.

Assuming that the specific heat of water remains at unity throughout the range of temperature, and that the heat mass or water equivalent of the kettles can be neglected in comparison with the water they contain, the absolute efficiencies come out as follows:

	A.		B.
Heat supplied (1)	256 B.T.U.	...	174 B.T.U.
Heat used (2)	162 B.T.U.	...	124·5 B.T.U.
Efficiency = $\frac{(2) \times 100}{(1)}$	63 per cent.	...	71·5 per cent.

This is sufficiently curious, but it shows that the time taken is a very important factor in determining the heat losses, and therefore the economy of the operation. The smaller kettle is actually the most efficient; but then it does its work in two-thirds the time required by its neighbour.

Two radiators, or rather a heater plate, and a radiator are cited in the paper. The curves given herewith show the



Time in minutes.

rate of rise of temperature in each case and the energy consumed, the energy being given by the ordinates to the energy scale, and not as is usual, by area. The heater plate shows a curious phenomenon. In 10 minutes it took ·116 B.O.T. unit, and in half an hour ·404 unit, more and not less than three times ·116 (·348), which one would naturally expect.

Assuming that it was run, as is probable, on a 100-volt circuit, it would be taking about 8 ampères, and apparently the current increased as it heated up, while naturally what would be looked for would be a decrease. The heater plate apparently gets rid of some 1,380 B.T.U. per hour, and the radiator about 1,700. A pound of coal, burned on an ordinary fire, radiates out into the room about 2,000 B.T.U., so that this large radiator, taking half a unit per hour, apparently does about the same duty as a pound of coal per hour burned in an open fire. Mr. Crompton states, with an electric griller, fully 70 per cent. of the heat energy in the electrical current is utilised in the meat.

The estimates of the efficiency of the customary cooking arrangements which are known to us agree very well. Mr. Crompton states that not more than 2 per cent. of the heat is utilised. Now Mr. W. W. Beaumont stated in the discussion on a paper by Mr. Nelson Boyd, entitled "Collieries and Colliery Working," read some time ago at the Society of Engineers, that he had made measurements and found that only 4 per cent. of the heat energy in the coal was put to any good service. These two figures agree, therefore, very well, considering that they must have been obtained "by difference," and this method of getting at results we all know is quite liable to give answers differing by 100 per cent.

Some two years ago we stated,* that electric kettles had been made which brought two pints of water up to the boil from 60° F. in 16 to 18 minutes, with an expenditure of 5 ampères at 100 volts during that time. Taking 17 minutes as the average period required, we find that 483 B.T.U. had been supplied to the apparatus, of which 380 B.T.U. appeared as sensible heat in the water. The efficiency works out at 78·5 per cent. Sixty watt-hours will suffice to boil one pint of water under favourable conditions, and even at the time of which we speak it was stated that 75 to 80 per cent. of the heat energy supplied could be guaranteed as a return. The loss is simply one of radiation and of the water-equivalent of the vessel to be heated with its contents. When these losses have been reduced to a minimum 90 per cent. return has resulted. In a later article† particulars were given of a one-pint kettle; it was stated that the time necessary to raise a pint of water from 60° F. to 212° F. by a rate of expenditure of 1,000 watts is 3·7 minutes. In this case the heat utilised is 190 B.T.U., and the heat supplied 210 B.T.U., showing an efficiency of 90·5 per cent.; but then pint kettles are usually made to take only 3 ampères at 100 volts, and are allowed 12 minutes to do the work.

In the discussion on Mr. Crompton's paper, Mr. A. R. Sennett pointed out that the mass of the utensil employed played a very important part in the economy of the process, and he took it that the utensils were made of the least possible weight. Another fact brought out was the difficulty met in making things, such as cigar lighters, which required concentrated heating, and which therefore reached a high temperature. Mr. Crompton mentioned that they were amongst the first things made, but often got out of order, because people left them on. The remarks made by Mr. Binswanger also bore out this point. He said that apparatus constructed with a large surface compared to the amount of current required to heat it, such as oven plates or radiators, were very durable, but that some qualification must be made with regard to apparatus of small surface with a large current, such as soldering irons, and even grillers and similar articles. These sometimes broke down, but the reason was not so much the mode of manufacture as the method of using them. This kind of apparatus should be used constantly, and the current should never be left on when not in use. Radiation should be in proportion to the amount of current used, otherwise the accumulation of heat would be too great, and the apparatus would break down. We have ourselves seen electric kettles destroyed by carelessness in this respect, and to some extent this is an inherent weakness. Radiators take care of themselves, and give no trouble, but with boiling apparatus it is different. If a kettle be allowed to boil dry, the bottom may get red hot and the resistance wire be damaged, but in such a case the fault is not in the apparatus, but with the management. Any case of a kettle burning out generally takes place in a drawing room. It is a pretty experiment, cited by Mr. Crompton, to take a piece of copper, drill an 8-inch hole in it lengthways, and drop into it a little miniature lamp; in a little time it will make the copper red hot. If the radiation be confined within certain limits, any temperature required can be got, however small the energy you have to start with; it is a mere question of time. This is the principle upon which Mr. Leslie Miller works when using incandescent lamps as the heating medium. One advantage with lamps is, that they have very little bulk to be heated; and another, that a lamp is the cheapest resistance that can be made. Messrs. Miller & Woods assert that by means of lamp heaters three-quarters of a pint of water can be made to boil for ·22d. * (at 4d. per B.O.T. unit), and this compares very well with Mr. Crompton's ·2d. for ¾ lb. of water. The efficiency is given as 75 to 80 per cent. in hot water, about 10 per cent. being lost in the metal of the pot and the remainder in radiation.

Some time ago we heard of a certain office in the west end of London which was fitted with electric kettles for the purpose of making afternoon tea for the staff and employés engaged therein. The firm who installed the wiring and fittings put in electric hot plates and flat bottomed tin kettles to be placed thereon. As a result, it was found from the supply company's bills and meter readings carefully checked during some of the summer months, that the cost of heating each kettle containing about a couple of pints was 6d.! Boiling water at the cost of 3d. per pint is a rather expensive luxury, and it is not surprising that these appliances gave way to ring gas burners after a short experience. This incident is recalled to mind by a paragraph in the Society of Arts' paper, in which it is given that heaters may be put to many useful purposes; they can be used as radiators of heat, and also for cooking purposes, if the food is placed on flat dishes or pans, care being taken that the lower surface of the pan comes into close contact with the upper surface of the heater; but, although cooking *can* be carried out in this manner, the use of separate heaters is not recommended, as there is always a loss owing to the lower surfaces of the pans not making sufficiently good contact with the upper surface of the heater, and it is therefore preferred to insure this contact by making the heating plate form part of the kettle or other similar culinary utensil. The great principle with electrical cooking apparatus is conduction, not radiation, and therefore for cooking what is wanted is the best possible contact—a very small film of air between the kettle or saucepan and the top of a heater plate Mr. Dowsing considers will reduce its economy nearly 20 per cent. As we have shown, it may have an effect certainly ten times this figure. Some time ago Mr. Dowsing was at work on a removable kettle which was V-shaped in section, and intended to drop into a triangular space between two heating plates. This does not appear to have been brought forward, and we do not know if it was found to be objectionable owing to the losses introduced by imperfect contact between the sides of the kettle and the heated surfaces. At any rate, it promised well and seemed likely to meet the demand for a removable water cistern which is not the case with the ordinary type of kettle.

It is interesting to hear from Mr. Binswanger that the first thing of the kind bought by a member of the general public is an electric kettle. At the same time Mr. Crompton thinks that there is no reason why in a few years to come the majority of the users of electric light should not do all their cooking operations of the nature of roasting, baking, stewing, and frying by electrical means, but that solid fuel may still be employed for boiling purposes only, and this in connection with a suitable furnace for supplying the whole of the hot water required for a household. Why gaseous fuel should not be mentioned is rather difficult to understand. Mr. Thos. Fletcher has told us† that out of the 660 B.T.U. per cubic foot of London gas, over 600 units are obtained in actual work in many commercial forms of bath heaters. Even in boiling a small kettle over an atmospheric burner, the average duty in practice is about 400 units. On this basis one cubic foot of London gas will give at least the heat work of 3½ ampères for 10 minutes, and three cubic feet

* Electrical Review, p. 618, May 26th, 1893.
† *Ibid.*, p. 350, September 29th, 1893.

* Electrical Review, p. 97, July 28th, 1893
† *Ibid.*, p. 669, June 2nd, 1893.

costing one-tenth of a penny will do the work specified as costing 1d. for the electricity used. If water boiling is such a difficult task then one is confronted with the statement of a correspondent (p. 691, vol. xxii.) that there is no case in cooking where the specific heat of the substance to be cooked is considerably under unity. Taking all the facts into consideration, one may accept the statement that "where intermittent use only is required, electric heating can often compete satisfactorily with coal, just as electric lighting has competed most favourably with gas."

ALTERNATING AND INTERRUPTED ELECTRIC CURRENTS.

II.

Last Tuesday Prof. Forbes, at the commencement of his second lecture, referred again to mechanical analogues, and said that they were a great help towards the understanding of what went on in an electric circuit. In the previous lecture he had shown how, by means of analogy, a clear conception could be formed of the actions taking place; but he desired to prevent anyone attempting to draw too much from the mechanical analogies, and thereby miss the complete analogy, perhaps to be led to wrong deductions. There is one defect, and that only a trivial one, in connection with the mechanical representation of a submarine cable; in it the resistance to the current is the friction of the glycerine and water with the thread and discs. This really varies as the square of the velocity, whereas the opposing force ought to vary as the current.

These devices are of more use to the mathematician than to anybody else, as by their means he is able to treat quantities more easily than he would be able to do otherwise. When Clerk Maxwell wrote his classical treatise, he was really thinking of mechanical analogies, and when viewed in this light, it is not difficult to understand the origin of the idea of "electric displacement," which is so puzzling to the electrician. The analogues, mechanical and electrical, are given in the following table:—

Electrical measurements.	Mechanical analogues.
Pressure.	Twisting force.
Current.	Rotary velocity.
Resistance.	Friction.
Charge.	Twist.
Capacity	Twist with unit force.*
Self-induction	Momentum.
Di-electric strength.	Breaking strain.

Example of Assumed Units.

Assumed	1 volt	1 ounce at 1 inch radius.
	1 ampère	1 revolution per second.
Deduced	1 coulomb	1 revolution.
	1 farad	1 revolution per ounce.
	1 henry	a cylinder 1 inch radius, weighing 62 ounces.

Taking two assumed units, all other units could be made to follow from these two. The proper values would be assumed so as to give the most useful relationship between the facts and the analogous case. Thus for experiments, on what we may call the Forbes mechanical artificial cable, if cable work were in question, it is probable that 300 revolutions per second would be taken as representing the ampère.

Oersted's fundamental experiment and discovery in electromagnetics was the starting point of all modern theory. From it, Faraday's experiments, in which a magnet pole was made to rotate round a wire, the induction between two wires, one or both carrying a current, and the induction of a current upon itself could have been foreseen by a philosopher who knew of nothing more than Oersted's work. Prof. Forbes then showed Faraday's experiment, illustrating the induction between one wire and another, and afterwards exhibiting the analogue of self-induction with a horizontal fly-wheel set into motion, and then either arrested or reversed. The effect of self-induction in choking an alternating current was explained by an experiment in which an incandescent lamp and small Gramme ring were run in series across, first on a continuous current circuit and then on an alternating circuit. The induction coil or transformer has been a great help to the electric lighting industry, but it has been infinitely more useful in electric power distribution. At Niagara Falls Professor Forbes was struck by the great variety in the demand for current which customers put forward. Current was required for lighting, for power, and for electrolytic work; some wanted a continuous current, others an alternating current; 150 volts was specified in some cases, 50 volts in others. Although Prof. Forbes did not consider it impossible to supply these demands by a continuous current system, it would have been very difficult, and the expense and trouble would have been simply enormous. Moving machinery in the shape of motor-generators would have been necessary.

The rise of pressure in a direct current circuit when the current is switched off was shown by an analogous experiment in which a stream of water flowing down a pipe was suddenly arrested. How thoroughly Clerk Maxwell's ideas were connected with mechanical phenomena when he was working out his electrical theories was shown by his invention of the model in which bevel gear wheels connect the different parts. In 1884 Lord Kelvin delivered the famous Baltimore lectures, in which he discussed the theory of the ether and the constitution of the molecule and made use of similar conceptions.

Coming to the combined effect of capacity and inductance, Prof. Forbes said he had tried to obliterate the effects of capacity in the work carried out at Niagara. By lowering the frequency of the alternating current below anything before attempted, he had done this as far as possible, and the result was a simplicity unattainable with higher frequencies. There was every reason for congratulation that a low frequency had been adopted, and the benefits derived made themselves felt more clearly every day. He had found that able manufacturers, relying upon experience, did not seem to appreciate how a whole system was endangered by breaking a circuit carrying current. All the attention was devoted to suppressing the spark at break, and the commonest way of doing this was to give a rapid break. Several experiments were shown to illustrate this point, but unfortunately the analogies, though good for continuous currents, did not represent the conditions with alternating currents.

Mr. Smith's "shunt transformer" experiment was shown.* Prof. Elihu Thomson's experiments were also exhibited and briefly described. Those who endeavour to repeat them should note that from 6 to 15 H.P. is required to show them properly. The only novelty was an electric gyrostat, which worked on the principle of the induction motor. This is not so well known as the jumping rings. At this stage the subject was dismissed until next lecture, which concludes the course.

* It has been pointed out to us that this should strictly be "with unit moment."

CORRESPONDENCE.

Storage Battery Testing Extraordinary.

My attention has been drawn to the first leading article in your current issue on a report made by Mr. Cuthbert Hall, consulting engineer, and editor of *Electrical Plant and Electrical Industry*, on the I.E.S. battery, of which you say you have received a copy, and which you publish.

So far as your article refers to Mr. Cuthbert Hall, that gentleman, as you have already experienced, is well able to take care of himself; but I am interested to know how you obtained a copy of the document mentioned, which is not the complete report, but is a private communication to me, summarising the result of the test he had made of the battery, and was accompanied by further details and curves.

Surely, in common courtesy, before publishing a private communication, you should have referred for permission either to Mr. Cuthbert Hall or myself, when we should have been pleased to have furnished you with the fuller particulars which we have.

No doubt technical men would have required the full report; but for commercial men, all that was necessary (for my purpose), knowing the reliability and capability of Mr.

* *Journal* Inst. Elec. Eng., Vol. xviii., 1889, p. 297, *et seq.*

Cuthbert Hall, was a summary showing the comparison between the best known accumulator and the I.E.S. Mr. Cuthbert Hall undertook these tests in consequence of a conversation I had with him some time since, in which he characterised as absurd the statements I made as to the results already obtained, and in which I offered to supply him with cells, and challenged him to disprove my statements. After making these tests, he admitted that I had been generally correct, and, at my request, supplied me with his details and the summary for my personal use and that of my friends, which you have published, and of which only a few copies, and those type-written, are in existence.

I cannot understand the hostile and intentionally damaging attitude adopted by what professes to be a leading technical paper like yours, without making any inquiries, to a new invention, which to my personal knowledge you have never seen, as also the similar spirit as shown by the fact that although you were not above soliciting and taking an advertisement from the I.E.S. Company for your Directory, yet you omitted to insert the company's name in the Directorial list.

Surely your paper exists honestly to examine, and bring before the notice of electrical engineers, improvements beneficial to their industry, absolutely without favour or prejudice.

The only definite and impersonal statement in your article is "that the figures and statements in it" (the report) "are transparently erroneous and reckless," and as I am so largely interested in the battery, and have such strong evidence to refute this, I must ask you to justify your statements, or withdraw them. In the meantime, I must also request you to publish this letter, in common fairness, as the trivial and intangible remarks contained in your article are calculated to mislead your readers, and injure the owners of what there is every reason to believe will prove the best secondary battery which has ever been put on the market.

J. L. Higgs.

P.S.—The general impression conveyed to me and others, on first reading your article, was that it should have appeared on page xiv., instead of pp. 493-4, in spite of your implied protest to the contrary.

[We publish the foregoing at the request of Mr. Higgs, as we have no wish to withhold anything he desires to explain; but here, as will be obvious from what follows, all correspondence must end. With regard to what Mr. Higgs calls common courtesy, there was nothing on the copy of the report to show that it was a private communication, nor that it was incomplete; copies of the document had been issued to members of the public, and in the public interests, and for the guidance of the technically ignorant commercial men to whom he alludes, we criticised its contents. On this point we may say that we fail to understand why commercial men to whom no doubt the circular was sent (with the same view to investment, we suppose, as all such circulars are sent) should not have had the fullest details of the tests. We utterly repudiate the charge of taking up a hostile and intentionally damaging attitude against the I.E.S. Company; challenging the accuracy of a report does not constitute hostility. Moreover, the statement concerning the Directory (which, to us, appears quite irrelevant, and respecting a matter concerning which the Editors of the ELECTRICAL REVIEW are not cognisant) is inaccurate, as Mr. Higgs will no doubt admit on reference to pp. 568 and 787. So far as Mr. Cuthbert Hall is concerned, he having issued a writ against us, the matter is *sub judice*, so naturally we refrain from any comment upon that portion of Mr. Higgs's letter.—EDS. ELEC. REV.]

Arc Lamp Standards.

In your issue of the 19th ult., Mr. Wilfrid L. Spence, on behalf of Mr. Deakin and himself, deliberately claims priority and sole right of manufacture for electric pillar ladders, for which they filed a provisional specification on April 30th, 1892. In your issue of to-day, however, he ungracefully climbs back a bit by acknowledging that Mr. J. B. Millar, of Messrs. George Smith & Co., "filed a provisional specification on *April 29th, 1892*."

Mr. Millar did not complete his specification, as he considered that after laying down the special plant necessary to turn these ladders out in the way his company can do, was amply sufficient to secure the position desired without the further protection of a completed patent.

Pillars and ladders exactly to the patent applied for by him can now be made by any firm (capable of doing so) without fear of infringement; and, so far as his company are concerned, they do not object to competition for these orders.

Geo. Smith & Co.,
SUN FOUNDRY, LIMITED,
J. W. B.

An Interesting Question.

At the station with which I am connected we have some 75 ampère flexible leads insulated with pure and vulcanised rubber and covered with cotton braid to withstand a pressure of 2,000 volts alternating current.

The two leads are together in a rubber tube of Silvertown's best quality.

We have repeatedly changed the rubber tubing but cannot get it to stand, and I would be glad if any of your readers could give me information as to whether this is due to some electrical action, or must I look elsewhere for the cause.

Switchman.

11, Pavilion Square, Scarborough,
April 30th, 1895.

Kingdon System of Electric Light Mains.

We beg to call your attention to enclosed Specification, No. 2,730, of a patent cable protector, granted to our late Mr. T. B. Grant on February 2nd, 1895, and would point out to you that the "Kingdon" system of laying underground mains described in your last issue is, in our opinion, covered by the above-mentioned patent.

Bourne & Grant.

Referring to the letter of Messrs. Bourne & Grant, a copy of which you have handed me, I now beg to hand you my patent specification No. 6,089, March 24th, 1894, relating to my system of electric mains described on page 468 of your issue of the 19th inst. You will see that my system of laying mains differs essentially from the Grant protector, which consists of a pitch and bitumen cover strengthened by metal strips or plates. My provisional specification, as well as drawings of my system, were in the possession of the late Mr. Grant early in last year, and some months before the date of his complete specification, December 5th. Two, at least, of the figures in Grant's complete specification appear to be modifications of my ⋂-channels, and there is no reference to these in Grant's provisional specification, whereas they are fully described in my provisional specification. Negotiations were in progress between the late Mr. Grant (who fully realised the distinction between the two systems) and myself for the use of my system at Chiswick and Aberystwith, and for the erection of plant for the manufacture of the channels and accessories, but, owing to the much regretted death of Mr. Grant, these have fallen through. In conclusion, I would call the attention of your correspondents to Sections 32 and 26 (4) (*a.*) of the Patents, Designs and Trade Marks Act, 1883.

I am quite prepared to guarantee to any purchasers of my system of electric mains, that it is not covered by Grant's patent.

J. A. Kingdon.

Owing to pressure on our space several letters are crowded out.

LEGAL.

SHELFER *v.* CITY OF LONDON ELECTRIC LIGHTING COMPANY.

In this action Mr. Warmington, Q.C., made an application to Mr. Justice Kekewich, sitting in the Chancery Division of the High Court of Justice on Friday last week. He said the plaintiff desired to restrain the defendants from acting on a building notice they had given with respect to pulling down a wall which plaintiff said was a party wall, and he did not want it pulled down pending an inquiry. But he understood from Mr. Renshaw, Q.C., who appeared for the defendant company, that they had no immediate intention of pulling down the wall. That being so, he would agree to the motion standing over generally, with liberty to apply on either party giving the other four days' notice.

Mr. Renshaw said his learned friend had correctly reflected the position, and he would consent to the order going as suggested; if defendants should want to pull the wall down, or otherwise move in the matter, they would give four days' notice.

His Lordship: Very well; let the order go, then, in the form suggested.

Whiffen and Others *v.* The Crompton Electric Supply Company of Australia, Limited.

This was an application by Mr. Butcher to Mr. Justice Kekewich to grant a receiver and manager in an action by a holder suing on his own behalf, and that of all other holders in three series of debentures issued by the defendant company, the interest of which was in arrear. Things were just now very bad in Australia, the learned counsel said, and to prevent wreckage, it was proposed to appoint as receiver the secretary of the company, who is resident in England, plaintiffs undertaking to be liable for his receipts, and to ask that a deputy receiver, resident in Australia, might have power to keep the undertaking as a going concern.

Mr. Justice Kekewich said he would appoint the secretary receiver, but as to the deputy resident manager, he must hear that in Chambers, as he thought it necessary that great care should be exercised as to the fitness of any gentleman for so responsible a position. The Receiver must not exercise any functions after October, when the Long Vacation would be over, if it should be found desirable or necessary to continue him alone in the position so long as that.

New Zealand Electrical Syndicate, Limited.

Counsel on behalf of Mr. C. F. Kemp asked Mr. Justice Kekewich to rectify the register of this company by substituting thereon his name for those of Mr. Frederick Williams and Mr. Horace Reginald Savory as the alleged holders each of 50 £10 shares in the undertaking. These shares, counsel explained, formed part of the assets of the Gülcher Company, of which applicant is the liquidator, beside holding in his own behalf some of that company's first debentures. They were standing in the names of one Pryor, as trustee for the Gulcher Company, and in 1893 the Gas, Water, and General Investment Trust, Limited, loaned the Syndicate some £25,000, he believed, part of the agreement being that the Trust should have some 2,200 £10 Gülcher shares, also some control in the Syndicate, whereof applicant was the largest holder of shares, by the appointment of three directors, of whom Savory and Williams were two. They qualified for that position by Pryor transferring to them the shares in question. Soon afterwards Savory and Williams transferred these shares back to Pryor; but on the transfer being left with the secretary to the Syndicate, who was also secretary to the Gas and Water Trust, they were refused transfer on two grounds: (1) that the transfer did not identify the shares by numbers; and (2) that the date of the year had been altered in the transfer, and this was so material a defect in the document, that he was justified in refusing to act upon it. Counsel having been heard for the Syndicate and Savory and Williams (Pryor not being represented), pointing out that applicant was present at the meeting of the Syndicate at which they were elected directors, and it must be assumed was privy to the whole proceedings.

Mr. Justice Kekewich, at the close of some three hours' arguments, decided that Pryor held the shares solely as trustee, and could not transfer them except by the direction of his principals, and though the secretary might refuse to accept the transfer because of the alteration in the date, which, however, had been explained, and might have been cured by initialling it, as the transferor held no other shares than these in the Syndicate, the objection on the ground of identity was invalid. Consequently he ordered the rectification to be made as asked for, by substituting the plaintiff's name for those of Savory and Williams.

The Planet Electrical Engineering Company, Limited.

Mr. Justice Stirling, on Saturday, in the Chancery Division, heard a motion for judgment, by consent, in the debenture holders' action, Wallace *v.* the Planet Electrical Engineering Company, Limited. The plaintiffs, counsel stated, held all the debentures issued by the company—£2,500—in December, 1893, the interest upon which was payable half yearly. No interest had been paid, and by this default both principal and interest became due and payable. On February 26th the company passed an extraordinary resolution for winding up, and in these circumstances the usual judgment was now asked, namely, a declaration that the plaintiffs were entitled to a charge on all the property of the company to secure repayment of the principal and interest of the debentures, and the usual inquiries as to who were the holders of the debentures, and what was due upon them. Counsel added that they did not meantime ask for liberty to sell, but for leave to apply in Chambers. His Lordship made the order in these terms.

Slade *v.* Hooper's Telegraph and India-Rubber Works, Limited.

In the Lord Mayor's Court, on Monday and Tuesday, this was an action by Messrs. Slade, Templeton & Co., engineers, of New Broad Street, to recover £114 for telegraph buoys and other goods supplied to the defendant company. The defendants paid £47 13s. 1d. into Court, and raised a set-off and counterclaim for the balance—£66 6s. 11d. The defendants, who were the contractors for laying a telegraphic cable in Cuba, had ordered 12 buoys, which were needed for the purposes of that work, from the plaintiffs. On behalf of the plaintiffs it was said that after the order was given, Mr. Basil Gee, the managing director of the defendant company, requested certain alterations to be made in the original specification. This caused delay in the manufacture of the buoys, which were made by Messrs. Danks, but ultimately the work was completed, and the buoys were shipped to Cuba. The defendants declined payment of the account on the grounds that there had been undue delay, that they had been put to expense in consequence, and that the buoys were not made in accordance with the order. Their counterclaim was made up of £55 16s. 11d., expenses to which the defendants had been put in consequence of the defects and delay in delivery, and £10 10s., expenses incurred in visiting Messrs. Danks's works, &c., to inspect the buoys. The principal question at issue was whether there had been unreasonable delay in delivery. The plaintiffs admitted that time was to have been of the essence of the contract, but said that in consequence of the alterations made at the defendants' request there was delay, and that they were only bound to deliver within a reasonable time, which they had done. The case was commenced on Monday, and on resuming on Tuesday, the learned Judge said it was not one which could be conveniently tried by a jury. He should, therefore, refer it to an arbitrator. After some argument as to the terms of the reference, a formal verdict was returned for the plaintiff for £98, and for the defendant on the counterclaim, subject to a reference to the Registrar (Mr. F. S. Jackson).

BUSINESS NOTICES, &c.

Ready.—The Universal Electrical Directory. This directory for 1895, which is on sale at 22, Paternoster Row, by Messrs. H. Alabaster, Gatehouse & Co., contains a total of 20,958 distinct names of individuals and firms, being 2,500 more than were contained in the previous edition, and about 8,000 more than any other electrical directory published. In addition to the incorporation of new names, all have been carefully revised, much financial information has been added, the telegraphic addresses and local telephone numbers are given, and the total of pages in the work is increased by 80, making in all about 866 pages entirely of directory matter Price 4s.

Bankruptcy Proceedings.—The creditors of Joseph Torr Todman, electrician, lately carrying on business at 36, Bermondsey Street and 11, Queen Victoria Street, met at the London Bankruptcy Court on April 26th, before Mr. A. H. Wildy, official receiver. The receiving order was made last January, but the debtor being then at Colombo, the proceedings were extended to give him an opportunity of attending the Court on his return to England. The chairman stated that no accounts had yet been filed, but he understood that the liabilities roughly amounted to £700. The assets included the debtor's interest in an arc lamp, the value of which had not yet been ascertained. On behalf of the debtor it was intimated that a composition of 7s. 6d. in the £ would be offered, and the meeting was adjourned for three weeks to enable the proposal to be lodged at the Court.

Mr. Samuel Elliott, of "smoke annihilator" fame, was examined before Mr. Registrar Hope, the other day, his unsecured debts being £65,000 and assets £8,200. The following points came out in the course of his examination:—In 1889 he began developing his smoke washer which "was eminently successful." He lost over £40,000 over it, sunk in a patent. For the last ten years he had been continuously overdrawing at the bank. The invention was sold to a Mr. Smith by whom it was placed before the public in January as the "Smoke and Fumes Annihilator," with a capital of £120,000. *Only* £7,000 *was subscribed by the public*, and in the words of counsel "the company ended in smoke," which Mr. Elliott's patent could not annihilate. Examination adjourned for the filing of further accounts.

Under the failure of Wm. John Kelly, described in the receiving order as H. J. Kelly, manufacturer of electric light fittings, 58, Bread Street, E.C., and 43, King's Road, Camden Town, the usual observations were issued to the creditors on Wednesday last. The accounts show liabilities £2,751 13s. 5d. and assets nil. According to the observations of the official receiver, the bankrupt states that having for 14 months prior to July, 1892, been secretary of Poole and White, Limited, electrical engineers, trading at the above addresses, he was in that month appointed receiver of the company's business at the instance of second debenture holders, but that in February last he was superseded by a receiver appointed on behalf of the first debenture holders, and that since then he has been without occupation. With the exception of a debt of £2 17s. 6d. the liabilities were contracted by him in his capacity of receiver, and although judgment has been obtained against him for several of such debts, he still denies personal liability.

Dissolution of Partnership.—The *London Gazette* contains notification that A. B. Gregson and G. E. Newbouit, formerly carrying on business as electricians and engineers at 12, Swaine Street, Bradford, under the style of Gregson & Newboult, have dissolved partnership, as and from the 20th ult. All debts will be attended to by A. B. Gregson, who will continue to carry on the business under the old name.

Ford-Lloyd Manufacturing Company.—Under the winding-up order made against the Ford-Lloyd Manufacturing Company, Limited, accounts filed at the London Bankruptcy Court show gross liabilities £5,025, with a deficiency to creditors of £3,394, and as regards contributions a total deficiency of £8,101. Mr. G. S. Barnes, the official receiver, in his observations, says the company was formed to take over the electrical business carried on by the

Ford-Lloyd Manufacturing Company together with certain patent rights. The nominal capital was £10,000, and the failure of the company is said by the directors to be due to want of capital.

Buluwayo Waterworks Company, Limited. — This Company has been registered for the purpose of acquiring two concessions granted by the British South Africa Company to Willoughby's Consolidated Company for the purpose of supplying the town of Buluwayo with water and electric light. The consideration for the water concession and construction of waterworks, &c., and providing £5,000 capital, together with the concession for the electric light supply, has been fixed at £175,000, to be paid in fully-paid shares, of which 125,000 have this week been offered for public subscription on behalf of the Consolidated Company.

Catalogues.—An illustrated price list of electric cooking and heating apparatus has been brought out by the Electrical Company, Limited. It contains a very good and complete collection of apparatus, in the use of which electricity is now made to play so important a part. The variety of articles mentioned denotes the vast field that is now opening up for the utilisation of electrical energy for domestic and general purposes. There are illustrated, electric hot plates, plate warmers, boilers, pans, saucepans, coffee cans, kettles, grills, flat irons, cooking and heating stoves, inhaling apparatus, lavatory basin with hot water supply, and other articles. The opening pages of the catalogue contain some general remarks and instructions necessary for those ordering or using such articles as the book describes. As far as possible prices are given along with the description.

Messrs. Green & Boulding have sent us a copy of their catalogue of the Buffalo automatic injector and various other specialities, which are priced and illustrated.

"D. P." Accumulators. — Up to the present these accumulators have been exploited by Messrs. Drake & Gorham who appointed Messrs. Johnson & Phillips sole manufacturers for the United Kingdom. It has now been decided to form a separate company known as the "D.P." Battery Company, who will take over the whole of the battery business from May 1st. The London branch of the company, to which all enquiries should be addressed, will be situated at 66, Victoria Street, Westminster, S.W., the works being at Old Charlton as at present. The company will retain the services of Messrs. Drake & Gorham, who, it will be remembered, were formerly managing engineer and works manager of the Electrical Power Storage Company, and were afterwards connected with the Elwell-Parker battery, so that they may be said to have had an exceptional experience in battery work. The works will be under the able management of Mr. Claude Johnson, of Messrs. Johnson and Phillips, and considerable additions to the existing large plant are meditated. It is hoped that this consolidation of interests trading under an independent title, which is less likely to arouse any possible jealousy on the part of the trade, will materially increase the business, which has already assumed very large proportions.

Decorations.—At a concert given by Mr. Broughton Black on the 23rd inst. for the St. Matthew's Institute, Kensington, at the Town Hall, Kensington, a novel feature of the evening was the electric illumination of the floral decorations for the platform by a number of 5 C.P. incandescent lamps interspersed amongst the plants. The storage batteries were kindly lent by Messrs. Peto and Radford, and the electrical accessories by Mr. Thos. G. Poole. The electrical arrangements were carried out by Mr. Ernest Roberts.

Electric Candle Fittings.—In further reference to this subject Mr. James Sugden writes:—"It may be interesting to all 'Patentees of rubber-bottomed candle fittings' to know that the idea is not by any means new. Mr. G. S. Sluce need not bring his solicitor, or any such weapon, into the field, for his candles were made about seven years ago. I made one about that time composed of stout rubber tube held at each end by two washers and cramped together by two screws. The screws were shortly afterwards abolished, and I used the arrangement on ordinary Ediswan candle fittings with nut for cramping. A good many were made, and have been made since. I did not consider the idea worth patenting since it has many disadvantages. The above ought to give to every reader a full right to 'make, sell, vend, or use,' rubber fixings to his candles."

Epstein Accumulators.—In addition to those mentioned a few weeks back for Kensington and Preston, the Epstein Electric Accumulator Company, Limited, have just obtained the order for two new batteries of large capacity from the Notting Hill Electric Lighting Company, Limited, to be erected at their central station, Bulmer Place, Notting Hill Gate, W.

New Edition.—A new and greatly enlarged edition of Mr. W. Perren Maycock's "First Book of Electricity and Magnetism" is about to be issued by Messrs. Whittaker & Co.

Personal.—Mr. W. Elsdon-Dew, who has been for two years manager and resident engineer of the Kelvinside Electricity Company's supply station at Glasgow, has been appointed resident electrical engineer to the Transvaal Gold Exploration and Land Company, and leaves immediately to take charge of the electrical plant at present in operation at their mines in the Transvaal.

Mr. S. Crichton Hannah, of 5, John Street, Adelphi, W.C., who has been for over 20 years designer for B. Verity & Sons, having severed his connection with the firm, is now in a position to supply designs and working drawings of all styles of electric fittings, iron work, &c., to the trade.

Alleged Theft.—A week or so ago we referred to a supposed burglary committed at the premises of the Brush Electrical Engineering Company in Queen Victoria Street. One of the company's office *employés* has since been charged with stealing the missing money (£237 10s.), and he has been committed for trial on the charge.

The Iniquities of Electricity.—"A man having the appearance of a mechanic," complaining of perpetual torture in his head, heart, and body, which he termed unnatural pain, and which affected him in whatever direction he went, "east, north, west or south," applied to a Bow Street magistrate last week for assistance. His worship's best nature was stirred within him, and he listened to the sad story with sympathetic interest. "What pains are they?" queried the magistrate. "How is it done?" Whereupon the piteous applicant for relief replied with certainty that this phenomenal effect "must be done by electricity. There's no mistake about it." All the magistrate could do was to say he could not interfere in the matter.

The Lillie Wire Joint.—The latest attempt in the direction of devising means for securing good joints is that of Mr. N. W. Lillie, of Somerville, Mass., whose joint is illustrated in the accompanying engravings, which are so clear as to require scarcely any further description. The wires to be joined are simply laid in the channels of an S-shaped strip of copper, fig. 1, and then twisted

FIG. 1.

FIG. 2.

until they assume the shape shown in fig. 2. According to the inventor, the walls of the connector are by this means drawn tightly into contact with the wires, while the overlapping edges of each channel press firmly against the outer surface of the other channel, forming a tight joint which thoroughly excludes moisture.

B. Verity & Sons.—We understand that this firm are very busy at their works. In the fittings and fixtures department they have secured during the past eight months the contract for the whole of the fittings for the Southport Municipal Buildings, Cardiff Town Hall, Burton and Worcester Municipal Buildings, amounting, in all, to several thousand pounds, and have just secured the order from the Dumfries Corporation, £1,100. With all these contracts in hand the brass work part of their factory is working overtime, and, further, there is such a demand for electric fittings out of Messrs. Verity's new wholesale catalogue that they have now decided to open a wholesale showroom in London. The new department opened a year-and-a-half ago for manufacturing and supplying all kinds of electrical accessories, has in hand several large orders for switches, sockets, &c., for leading electrical firms in London and the provinces, and there seems to be a very satisfactory awakening of business all round the country. From the increasing demands of this class of apparatus during the last month another machine shop has been opened at the factories, and new machinery is being put down to cope with the work. The firm's forges are at present engaged upon a large order for ornamental work for the new General Post Office. Their catalogue of electrical accessories will be ready shortly.

Westminster Electric Cricket Club.—Mr. W. A. Pearman, the Hon. Sec. of the Westminster Electric Cricket Club, has sent us a list of fixtures for the season. The home matches are played at Freemasons Ground, Denmark Hill. Some strong teams are to be met, but we trust the Westminster Club to give a good account of themselves.

ELECTRIC LIGHTING NOTES.

Aberystwyth.—We understand that operations are in hand for laying a second cable for private lighting purposes. A local paper says that the public lamps already erected give every satisfaction.

Acton.—The District Council the other day discussed whether they should rescind the resolution by which they decided to sell their provisional order to Messrs. New and Mayne. The opinion of the parochial electors is to be taken before the matter is settled.

Bath.—At a recent meeting at the Christ Church Congregational, there was a discussion as to the lighting of the church. Negotiations are proceeding in regard to installing the electric light, a generous offer having been made in regard thereto.

Bedford.—On the 19th inst. a member of the Police Authority moved the adoption of the electric light for the Shire Hall, at a cost £79 odd, but no one seconded his proposition, and the matter was postponed for 12 months.

A report just issued by the Electric Lighting Committee gives an approximate statement of receipts and expenditure to date as follows:—Johnson & Phillips machinery, £4,160 paid, £1,200 owing; Telegraph Manufacturing Company, mains, &c., £2,599 5s. paid, £102 10s. 1d. owing; ditto, additions and stores, £457 6s. 4d. owing; Grafton & Co., travelling crane, £85 paid; T. H. Coleman, building and shaft, £1,600 paid, £341 16s. 5d. owing; F. H. Medhurst, commission, &c., £786 16s. 4d. paid; meters, £413 9s. 2d. paid, and other expenses making the total amount paid £10,644 2s. 8d., and the amount owing £2,138 14s. 10d. The Committee have every reason to be satisfied with the way in which the light has been taken up in

all other parts of the borough where the low tension mains have been extended. The total number of 10 C.P. lamps or equivalent connected with the service is about 3,000. The Committee have made important experiments in lighting the streets by means of incandescent lamps, and they are glad to be able to report that the experiments have been successful. The Committee are unable to say precisely what the exact income will be until the meters have been taken, but the number of units supplied from the station from December 5th, 1894, up to and including the 31st day of March, 1895, is 12,880, and this number calculated at the price charged to customers, viz., 6d. per unit, represents £322. This sum will recoup the authority all the working expenses and materials supplied at the station during this period, and provide a small balance, a result which the Committee submit is satisfactory. The working expenses from December 5th, 1894, up to and including March 5th, 1895, are as follows:—Fuel, £145; insurance, £6 12s. 9d.; wages, £79 18s. 3d.; oil and cotton waste, £7 7s. 9d.; engineer's salary, £45 6s. 8d.; and other sums £298 12s. 5d. The report deals at length with proposed extensions, and suggests application being made to the Local Government Board for power to borrow £27,000. The report was unanimously adopted by the Council.

Bexhill.—The St. Peter's Church authorities have an increased financial deficit this year, because they had to provide "a fund for the renewal of the storage batteries of the electric lighting apparatus necessary at the expiration of four years."

Birkenhead.—The Finance Committee in their estimates for the year 1895, include £1,500 for the purpose of electrically lighting the Town Hall. The Council, however, have in discussing the estimates reduced that sum by one half, making it £750.

Brighton.—The Lighting Committee having again considered a letter respecting the lighting of Regency Square, have resolved that the question be postponed for the present in view of the possible extension of electric street lighting.

Buluwayo.—This town, of very recent development, is likely to be more up to date than some old towns at home that we might mention. It is to be lighted by electricity, and for this purpose the Buluwayo Waterworks Company has been registered, and a prospectus issued.

Coventry.—There was a discussion at the last Council meeting as to the relative prices of gas and electricity. Some of the speakers discredited the statement, for which Mr. Hammond was responsible, that electrical energy at 6d per unit, compared, light for light, with gas at 4s. per 1,000.

Fulham.—The Vestry has appointed a committee to consider the electric lighting question, and the erection of a dust destructor in connection therewith.

Glasgow.—The new Empire Palace will be lighted throughout by electricity.

Hanley.—A report has been adopted by the Council regarding the extension of the electricity works and mains to a large number of streets at present not supplied. The estimate for the cables, including laying, is £5,508. The extensions of the mains require the provision of 16 sub-stations, 20 transformers, 25 junction boxes of various kinds, and 30 arc lamps and posts. The estimates for these, including the extensions at the generating station, amount to £5,900. Arc and other lamps, including the extension of the main switchboard arrangements, and a sum of £322 for excavation, formation of ground and railings at the generating station, are estimated to cost £1,242. In consequence of the increasing demand for electrical energy within the compulsory area, considerable extensions have been made to the machinery, mains, sub-stations and transformers, amounting to £2,650, and the buildings, furniture, excavating, drainage and formation of ground amounting to £2,000. These items, together with several others not included in the original application, amount to £4,850. There is also a sum of £1,500 in respect of meters. Total estimates for extensions, including contingencies, £20,000. The following is given as a summary of the electric lighting scheme:—

First application	£21,000
Second application for meters, &c.	1,000
Third application for new steam alternator ...	5,000
Present estimate	20,000
Total	£47,000

Application is to be made to the Local Government Board for sanction to borrow the further £20,000 required, repayable in 25 years.

Heysham.—The ratepayers of the Sandiland's district of Heysham have been considering the lighting question. Negotiations have been proceeding between the lighting inspectors and the Morecambe Electric Lighting Company. The question of lighting the front has now been postponed until the end of the year.

Killarney.—There appears to be a real Irish muddle at Killarney over the lighting matters. There are both gas and electric lighting interests in the town, and the Local Commissioners have had a little trouble with both concerns. There has been litigation over the matter, and the Commissioners have been the losers. Last week the lighting question was again up for discussion, and after a lengthy squabble the adjournment of the matter was carried by five votes to four.

Kingston.—The Council, through the Lighting and Market Committee, are prepared to arrange for fixing electric fittings to the labouring classes dwellings in course of erection in Pheasant Lane, current to be charged for by way of a fixed sum to be paid with the rent.

Liverpool.—A local paper, referring to the inspection of books being carried on by the appointed expert, says that "it is now highly probable that the Liverpool Electric Supply Company will agree to sell their business to the Corporation for the sum of £400,000."

London.—The London County Council Money Bill, which has now passed the examiners on Standing Orders, provides among other things for the electric lighting of the Victoria Embankment and the Waterloo and Westminster Bridges, at a cost of £21,000.

Maidstone.—Mr. Thomas King proposes to form a local company to take over the provisional order obtained by the district council. The electric lighting committee will shortly report upon the proposal.

Manchester.—The Manchester Corporation have nearly completed the erection of cattle lairages and cold stores and chill rooms, for the convenience of the cattle and meat trade. The buildings are to be electrically lighted, the engines and dynamos being already in position, along with the refrigerating machinery and the driving fans.

Newcastle.—The Town Hall is to be renovated, and one of the improvements will be the introduction of the electric light, the cost of which is estimated at £470.

Plymouth.—A ratepayers' meeting last week discussed various matters of importance to themselves, and the opinion was expressed that the town was behind the times in the matter of lighting. Dr. Square being desirous of hitting the nail on the head, moved that an installation of the electric light be adopted. It was, however, thought that an entire meeting should be devoted to the matter, and this point was referred to a committee.

Rothesay.—The Council have at present under consideration the advisability of lighting the pier by electricity, at an estimated cost of over £1,000. The proposal is to erect a 30-H.P. turbine wheel, driven by water from Lochfad. The yearly cost is estimated at £280, against £150 for gas. We are informed that the scheme is likely to be strenuously opposed unless the Esplanade and other parts of the town are included in the scheme.

Ryhope.—The Ryhope Co-operative Store was lighted by electricity for the first time on the 20th inst. Messrs. Burnett & Co., Newcastle, laid down the plant, which includes 200 incandescent lamps and six arc lights. The cost was £1,000.

Shanghai.—They have their meetings of ratepayers at Shanghai, and about the middle of March such a meeting discussed the lighting of the settlement. It was shown that the electric lighting had been a thoroughly successful enterprise for the municipality since it was taken over two years ago. One speaker was so enthusiastic that he recommended the authority to push the electric lighting scheme energetically, so as to annihilate the gas company. Two years ago Shanghai was supplied with 82 1,000-C.P. arc lamps, and 2,000 incandescent.

Ships.—A new steamer, the *Grenadier*, just launched at Walker-on-Tyne, is to be lighted throughout by electricity.

Shoreditch.—The Vestry are wanting a clerk of works to look after the erection of the electric lighting buildings.

Southampton.—The secretary of the I.L.P. recently wrote asking the Town Council to at once take steps to purchase the electric light works in the town, as their right to do so would shortly expire.

Stafford.—The electric lighting works are nearly completed. The laying of the cables will shortly commence, and in six weeks everything will be entirely ready. Applications for light are coming in satisfactorily, and the staff at the works are fully engaged wiring up premises.

St. Helen's.—The gas committee, having received a report upon the question of supplying electricity within the borough, decided to ask Mr. Hammond to report further as to the comparative cost and advantages of (1) augmenting the present plant at the Town Hall in order to make provision for the lighting of the Gamble Institute, such plant to be ultimately utilised in any general scheme for the provision of electricity within the borough; and (2) putting down such a plant at the gasworks. The further report having been considered, the committee now recommend the council to approve putting down plant at the Gasworks capable of supplying the Town Hall and the Gamble Institute, and any further immediate demand, and also capable of extension as the demand should increase.

Sunderland.—The electric light was used in the Corporation reading room, library, and entrance hall, for the first time on the 27th ult.

Trinidad.—On March 5th, Port-of-Spain, the capital of Trinidad, was lighted by electricity for the first time. The new light has taken the place of oil lamps.

Tunbridge Wells.—A very complete installation of the electric light, as adapted to photo-etching, has been erected on the premises of Messrs. Carl Norman & Co. The installation consists of a 6 H.P. gas engine, which drives a dynamo capable of developing 75 ampères at 105 volts. In the studio are three arc lamps. The installation was designed and fitted up by Mr. H. J. Rogers, M.I.M.E., of Watford.

Woking.—In regard to our note last week of the failure of the electric light supply at Christ Church, causing sudden recourse to antiquated methods of lighting, Mr. A. J. Wheatley, the engineer of the Woking Electric Supply Company, Limited, writes to us as follows in explanation thereof:—"In your Note the cause of the failure is not stated, and as it might give the impression that it was caused by failure of the supply, I wish to state that it was due to the "blowing" of the fuse which controls the chancel lights, and may have been brought about by a temporary short circuit due to the Easter decorations or otherwise. The installation having been tested and the fuse replaced, no more trouble has been occasioned since."

York.—On Monday, there was a lengthy discussion at the City Council meeting regarding the report of the Streets and Buildings Committee recommending the scheme of the Electric Construction Company for the electric lighting of the city, as being most suitable for adoption by the corporation, and further recommending the acceptance of the tender of this company to supply the necessary plant and fittings for the sum of £10,865, and to work the plant for a term of three years in consideration of the payment to them by the corporation of the following charges per unit for electricity supplied:—3¾d. per unit on a minimum of 75,000 units per annum, and on quantities up to 150,000; 3¼d. per unit on 150,000 to 300,000 units per annum; 2¾d. on over 300,000 units. The report was ultimately referred back to the committee, with an instruction to report further on the electric lighting question, and particularly as to (1) the entire cost of plant, buildings, and land in each case; (2) the various works visited by them; and (3) whether Prof. Kennedy agrees with the advice given to them by the city engineer.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Belfast.—The Electric Committee of the Corporation have decided that the charge for current used during the day and for motive power purposes shall be 4d. per unit, the charge for lighting being 7d. per unit.

Coventry Tramways.—Were the circumstances preliminary to the introduction of electric traction in provincial towns often similar to those which have ruled at Coventry, there would be less occasion than at present for one to wonder why the progress in this branch of the electrical industry drags so drearily along in this country. The late London County Council are responsible for sending into a trance a scheme of overhead electric tramways which was proposed for a certain London district, and the Coventry local authority has been largely responsible for the prolonged delays that have occurred in the equipment of an existing tramway line within the district under their jurisdiction. Coventry is, however, to have its electric tramways at last, for we learn that a contract for the electrical equipment has been placed with the General Traction Company, of Westminster, and the work is to be started without further delay. It is interesting to note that in this instance over two years have passed from the date upon which the proposal to introduce electricity was first mooted. Mr. W. S. Graff Baker at that time was the proprietor of the local tramways, and the General Works Committee, in trying to come to an agreement with him, were desirous of making modifications and rigorous stipulations in regard to that agreement, and these suggestions and other matters brought affairs to such a pass that it seemed electric traction would have to stand out of the way altogether. We are glad, however, that after all the various delays and hitches of one kind and another that have arisen, a settlement has been arrived at, and accordingly, if everything else goes satisfactory, the line may be in operation before very long.

Douglas and Laxey Tramways.—The postal mails are to be carried over this line after July 12th, instead of by ordinary carrier.

Dublin-Dundrum Proposed Tramways.—A Dublin paper is responsible for the statement that a movement is on foot for the provision of better travelling accommodation from Dublin to Dundrum and the neighbourhood. An electric tramway is suggested, the new line to start from the United Company's line at the head of Eglington Road, where connection would be established with the whole of the Dublin system. The other terminus would be at the Manor Hill Laundry, Dundrum, a total distance of about three miles of line to be constructed. It is said that a guarantee fund has been raised among the residents.

Electricity in Mining.—A mining contemporary says that the electric power plant which was recently put down to work the Avalanche Mill (Forbes Reef) has been started and works satisfactorily.

Great Northern and City Railway.—The failure to secure the necessary applications for shares to allow the promoters of this railway to go to allotment, was followed by their application to Parliament for the insertion of an additional provision in their Bill, whereby they would be empowered to use steam locomotives as well as, or *au lieu de* electricity. The Standing Orders Committee, however, have just given their decision that the Standing Orders not complied with by the promoters with reference to this additional provision ought not to be dispensed with. This means that no further steps can be taken this session to alter the motive power upon the authorised railway. Let us hope that in the meantime it will be found that the investing public is more willing to support the system first proposed.

Llandudno Proposed Tramways.—At the last District Council meeting a letter was read from the Electric Tramways Company stating that "notwithstanding the result of the recent poll, they intended to promote a provisional order next session for the construction of the works, and with a view of obtaining the acquiesence of the Council, stating that they were prepared to make certain modifications." Mr. Ellis Jones considered that the Council was bound by the decision of the ratepayers, who, after a poll, had pronounced against the proposal. An interview was granted to the company's representatives, and the proposed modifications to the scheme were explained, it being stated that, "as regarded electric lighting, the company were prepared to supply the Council with electrical energy at wholesale prices, and thereby avoid the necessity of providing an expensive generating station; not to run Sunday trams, and to construct only a single line through Mostyn Street." It was added that there was a considerable feeling in the town that the tramway, instead of being prejudicial, would be advantageous to the district, and that a favourable opinion had been expressed by Conway, Colwyn Bay, and the other local authorities who would be affected by the scheme. The spokesman said that the promoters had spent a good deal of money—approximately £2,000—and they were not likely to abandon the scheme after such an expenditure. A resolution was afterwards passed declining to reopen the question. Once upon a time the idea of steam locomotives was laughed out of Parliament. But they were doomed to come, though, at first, the people quaked with fear. Electric traction has been treated in a few places in a somewhat similar manner, perhaps not so harshly, and the unreasonable opposition which is now raised at Llandudno cannot stay the course of progress very long. We hope the ratepayers will treat the matter fairly and change their views, or that their opposition will have little weight with the Board of Trade, should the matter come to that pass.

Pumping and Haulage Machinery.—Messrs. J. C. Howell & Co. are fitting up electric pumping plant at the Gwaun Cae Gurwen Collieries, and later on a proportion of the haulage is also to be done by electricity.

TELEGRAPH AND TELEPHONE NOTES.

Cable Repairing.—We learn that Mr. G. R. Mockridge, the superintendent of the Western Union Cable Company at Penzance, is proceeding on board the steamship *Faraday* to a point off Newfoundland with the object of picking up and repairing one of the Western Union cables. Mr. Mockridge will watch the interests of the company. The cable has been broken for about 12 months, and an attempt last year to repair it was unsuccessful on account of the bad weather.

Edinburgh.—The Edinburgh Merchants' Association has petitioned Parliament in regard to the unsatisfactory condition of telegraphic communication, and recommending the taking over of the telephone service by the Post Office.

The Edinburgh Town Council have decided that before the National Telephone Company proceeded further with the work of erecting telephone poles and apparatus in the neighbourhood of Bruntsfield Links, the magistrates and council suspend the standing orders, and, in the interest of the amenity of the district, withdraw the permission granted to the company for this extension.

International Telegraphic Code.—The Leeds Chamber of Commerce last week considered a communication from the Commercial Telegram Bureau, pointing out certain defects in the proposed international telegraphic code, which is to come into operation in 1898, and asking for the aid of the Chamber in securing necessary amendments. The matter was referred to the Parliamentary and Legal Committee of the Council.

Shanghai Telephones.—The *North China Herald*, in a recent issue, pays a tribute to the satisfactory working of the telephone in Shanghai, and to the improvement in the lines during the last year or two.

The Parliamentary Telephone Committee.—Pressure upon our space prevents our publishing in this issue the report of Tuesday's proceedings of this committee.

The Proposed Pacific Cable.—Information received at Ottowa indicates, says the *Times* correspondent, that there is no possibility of securing a station for the proposed Pacific cable in the Hawaiian Archipelago. The advocates of an entirely British route will not regret this, as they prefer that Fanning Island should be selected. The Imperial Government is being urged to summon a conference of the colonies concerned to arrange the details of the construction of the cable. A *Times* despatch from Melbourne says that Mr. Larke, the delegate of the Canadian Government, has proposed to the Sydney Chamber of Commerce a scheme for the laying of a Pacific cable by Great Britain, Canada and Australia. The cost would be £1,600,000, which would be borrowed at 2½ per cent. interest. It is estimated that half the present business at 2s. a word would repay the capital in 25 years, besides the annual expenses.

DECORATIVE ELECTRIC LIGHTING.

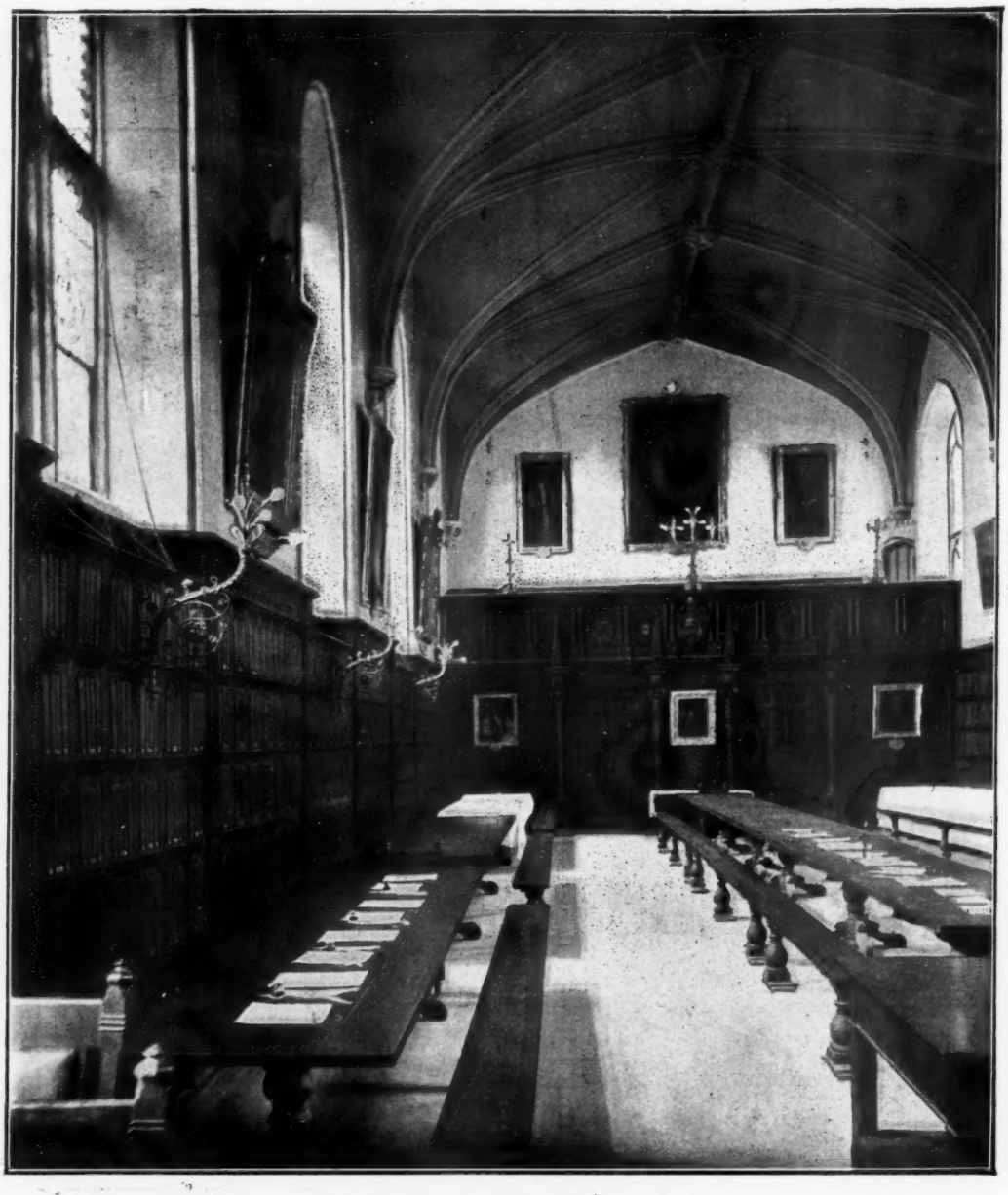
DECORATIVE electric lighting is a subject which, perhaps, does not stir very deeply the feelings of the average electrical man. Yet even he must feel some interest in the advantage that is being taken of the applicability of electric lighting to all manner of decoration. Apart from the admirable treatise by Mrs. J. E. H. Gordon, the subject has not been dealt with very fully in print, though an art critic in a recent issue of an art journal deems it important enough to warrant him perpetrating some designs for the edification and emulation of the makers of electric fittings.

The amateur wing of the great army of art decorators has gone through some trying phases in moulding electric lighting to its wonderful schemes of decoration. Time was when it set up storks with weak knees holding lamps in their mouths; then it sighed for winged eagles and magic rocs, and failing these fell back on poultry; but it became more sweetly reasonable, and abandoning the feathered tribes, became enamoured of graceful acanthus leaves. In spite, however, of an occasional lapse into tawdriness and ostentation, the amateur art decorator appreciated the important fact that the source of light ought to be concealed as far as possible from the eye. Occasionally he did this not wisely but too well.

It may be objected that in the illustrations which accompany this article, the electric fittings are not sufficiently prominent, but we would point out that the best lighted rooms are those in which one is not conscious of the manner in which the light is produced. Indeed, it is recognised that to light a room on true scientific methods the light must be sub-divided, and the acceptance of this principle involves the abolition of the large chandeliers and other arrangements which mean a concentration of light. We can quite understand, and, indeed, appreciate, the desire to retain existing handsome candelabra,

ST. STEPHEN'S HALL, HOUSES OF PARLIAMENT.

and to modify them to suit the electric light, but such adaptations are not always pleasing; though in the case of the House of Commons and some of the Oxford Colleges the change has been effected with the greatest possible success. The number of examples of fittings to which the electric light has been applied is really astonishing. It has been made to imitate wicks floating in oil, notably at Worcester College, Oxford; it has been fitted into ancient Venetian lamps, which have cost moderate fortunes; it has been made to resemble the oil flame from a Pompeian lamp; it has been arranged behind Cairo lattice-work to emulate sunshine; while the most common use, and perhaps the worst, has been to make it approximate unto the ancient but objectionable candle. A most interesting and effective use of electric light has been made at the Royal Holloway College, Egham, which, by the way, was fitted by Messrs. Verity & Sons about three or four years ago. In every nook and corner of this building electric lamps have been placed. We have selected two rooms as illustrative of the general methods that have been adopted in this institution, which certainly show considerable regard for the different conditions under which the electric light was required. The Picture Gallery, which is 100 feet long and 30 feet in width, contains many admirable pictures, considered by critics to be well hung. It is enough to show the importance of the collection, when we mention a few of the examples: Luke Fildes, "Applicants for Admission at a Casual Ward;" Sir John Millais, "Princes in the Tower;" Frank Holl's "Committed for Trial;" Constable's "Views of the Stour," and pictures by Long, Pettie, MacWhirter, Ansdell, and others. The whole of the lighting is done by lamps fixed on five electroliers, not too heavy, and fairly ornate. It will be observed that there has been no attempt at lighting the pictures individually, but the light from the 90 lamps is diffused uniformly over the entire room. The lamps are placed in an upward direction, the shade underneath preventing the fila-



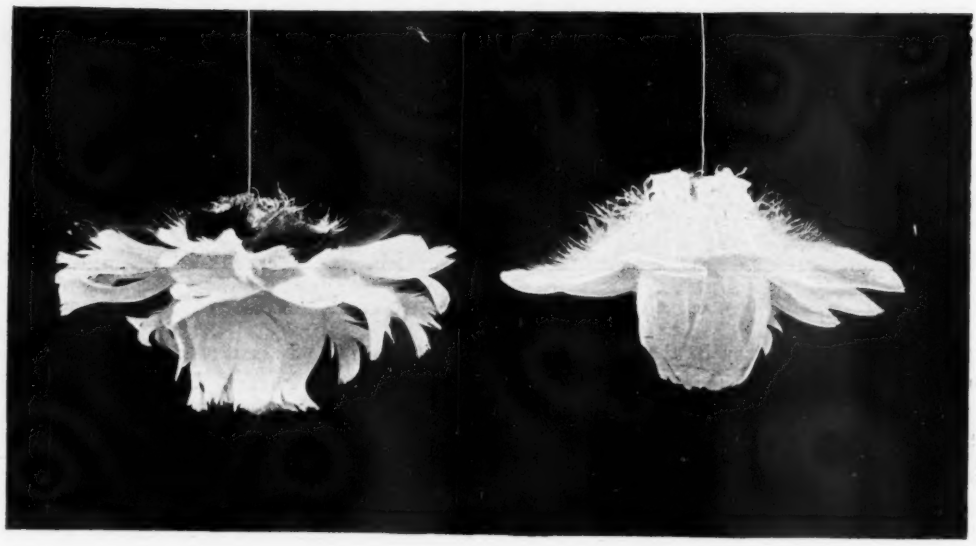
Magdalen College Dining Hall, Oxford.

ment from falling direct on the eye. It will be seen from the general arrangement of the lamps that most of the light will be reflected from the ceiling; indeed, judging from the lightness of colour on the higher walls, this was no doubt the object of the designers. Our second view of Egham is the library, and here again the lamp filaments are prevented from falling direct on the eye by means of properly arranged shades. By reason of one of the lamp standards being in the foreground, it may be thought they are too large to be quite in keeping with the style of the room; but they harmonise exceedingly well with the surroundings, and are not too prominent. We are much indebted to the authorities of the Institution, who were good enough to allow us to take photographs.

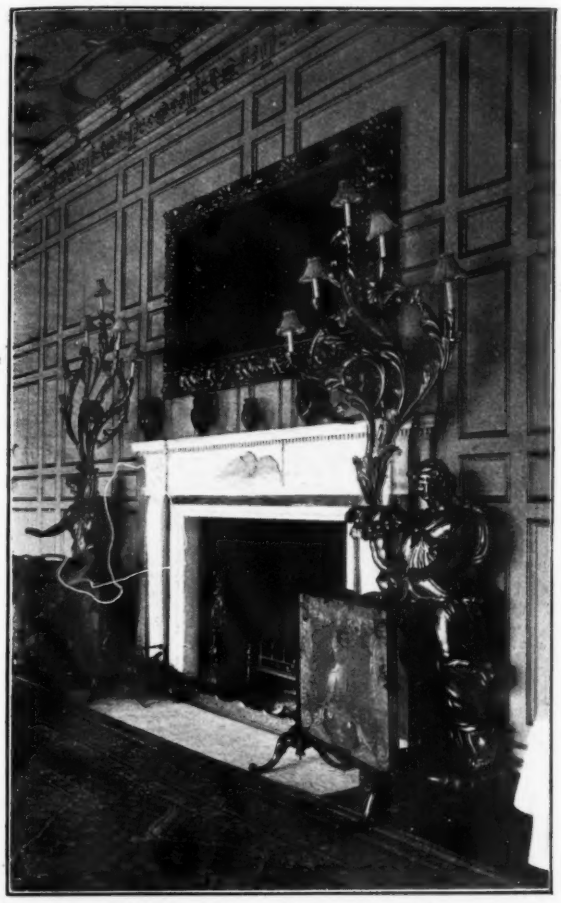
Picture Gallery, Royal Holloway College, Egham.

In the beautiful old dining hall of Magdalen College, Oxford, the lighting is done from six wall brackets and from three standards, which are placed on the elegant screen at the end of the hall. The side brackets have each a cluster of four lamps; the centre standard on the screen bearing three clusters of four lamps, while the two at the side have each a cluster of four lamps. In lighting the colleges it was necessary to keep in view one desideratum—that was, to introduce the electric light with the minimum of alteration to the existing lighting fixtures. In most cases this has been done in the most praiseworthy manner. In the Magdalen Hall, the old gas brackets have been used for the incandescent lamps, the electric light leads being taken to the lamps through lead pipes; they have been so skilfully arranged, however, that they are not obvious from a casual inspection. We believe that on the introduction of the electric light, the college

Library, Royal Holloway College.



Plume Shades.



Lighting Arrangements in Gilt Dining Room, Warwick Castle.

Plume Shades.

Lighting of a Drawing Room.

authorities rather feared an interruption in the supply, so by using the old brackets they have been able to preserve the gas service in its integrity. The lighting of Magdalen is rather inclined to the useful than to the beautiful. It was the chief desire to obtain a good light, so for some time large lamps were used; these were not protected in any way, and created a brilliant, but glaring effect, and to avoid the image of the filament impinging on the eye, smaller lamps with frosted globes were substituted. The arrangement of the lamps is open to some considerable improvement, but this would be impossible if it were desired to retain the use of the old gas brackets in their present position.

done, and though the effect is curious, it is distinctly serviceable. There is a fairly uniform diffusion of light, which is quite in keeping with the ecclesiastic character of the building. An important advantage has been gained by this arrangement, for during divine service the light does not fall direct on the eyes of the worshippers. There were insurmountable difficulties in the way of obtaining a photograph which would show clearly the special characteristics of the chapel; a prolonged attempt was made to secure one for this article, but it was unsuccessful.

At Wadham College electric light has been substituted for gas, with very little alteration to the old fittings; the chan-

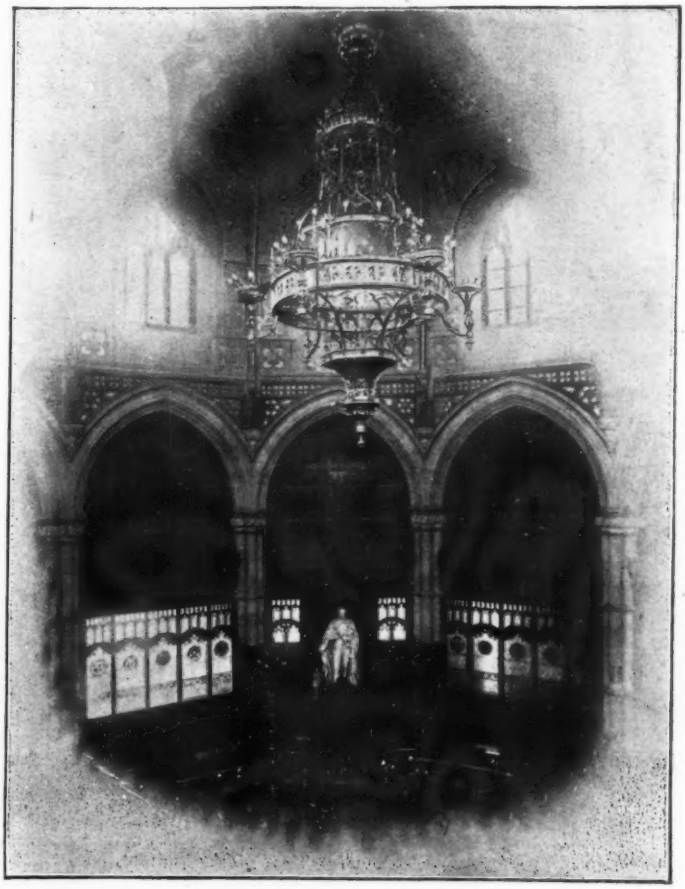
Bell Moor, Hampstead.

The photograph of Magdalen Hall, which was taken by a member of our staff, though an exceedingly good one considering the light, does not reveal much of the delicate carving on the screen. It, however, gives an exceedingly good idea of the lighting arrangements.

In the introduction of electric lighting into the ante chapel at Magdalen College there was great difficulty. It was sought to utilise as far as possible the existing gas standards, which are fixed in various positions on the floors of the chapel, but it was found that this was impossible, unless portions of the stone floor were removed; the remedy was, however, too heroic, so it was decided to place the lamps round the moulding of the side walls. This has been

deliers on which incandescent lamps are now placed are distinctly handsome, and we can quite understand the college authorities being loth to see them disappear. On artistic grounds it might have been advantageous to remove them, and indeed, to gain the most complete form of lighting, a more sub-divided arrangement was necessary, nor would such an alteration have detracted from the venerable character of the building. Having regard, however, to the difficulties, we had almost said the prejudices, which the introduction of electric lighting into ancient buildings has met with, the college authorities of Oxford are to be sincerely and wholly congratulated on the spirit in which they have received electric lighting.

It is to be regretted that we have not been able to secure for our collection an example of ecclesiastic lighting. There are numerous churches at the present moment lighted by electricity, indeed, in some London churches there have been some exceedingly good methods adopted, notably at St. Peter's, Vere Street, lighted by Messrs. Strode & Co., and the Parish Church at Woolwich fitted out for the light by Messrs. Benham & Froud. In a conversation with Mr. Laws, the managing director of the latter company, as to church lighting, we were assured that the greatest prejudice had existed with regard to the introduction of electric lighting into places of worship, though it was now rapidly disappearing, and churches were being lighted by electricity quite as rapidly as were private houses. The advantages of a good system of electric lighting are perhaps more appreciated in churches and chapels than elsewhere. We need sarcely point out the uncomfortable state to which places of worship are brought at a crowded evening service where gas lighting is in vogue, and a system of ventilation is unknown. The introduction of electric lighting into churches, however, has, besides improving the atmosphere, had another very important result; it has caused to disappear almost absolutely those old gas standards, which were a great source of amusement to small boys. Hanging lights are now almost universally adopted for the interiors of churches, and as these are generally adequately divided, the effect is much improved.



Council Chamber, Guildhall.

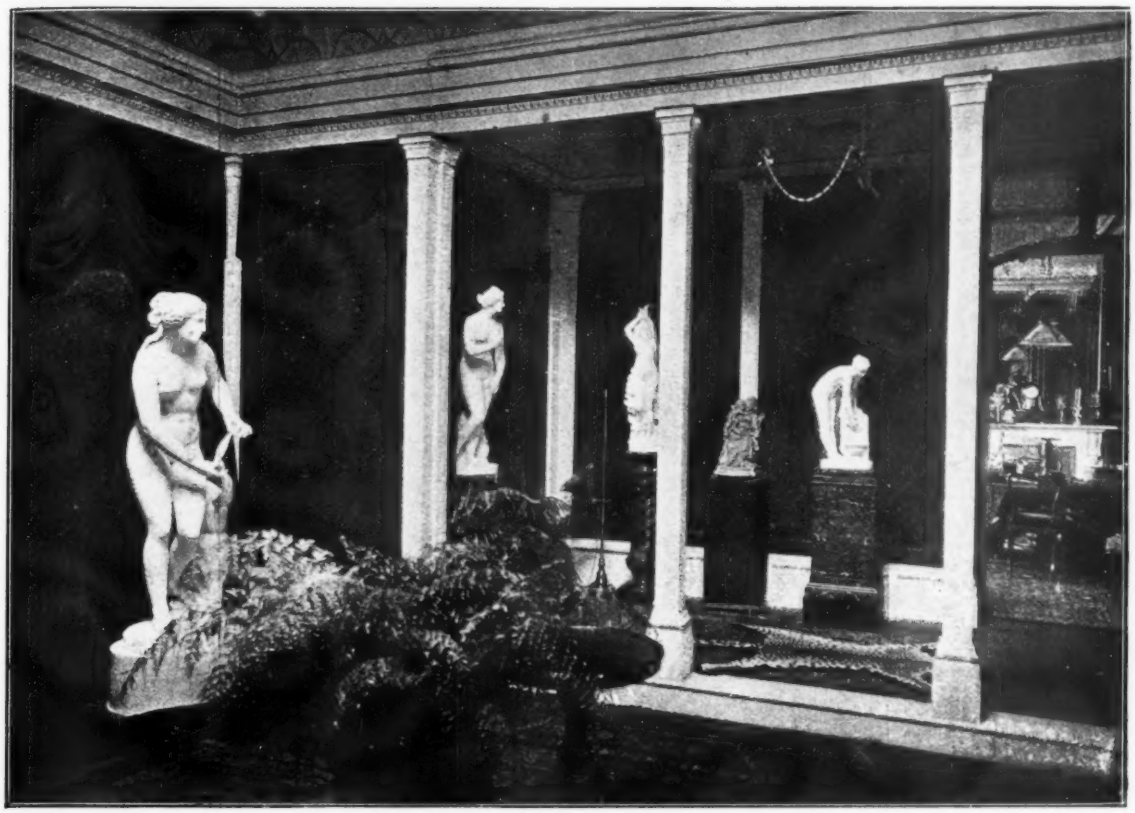
There is, however, one form of lighting which, in the eyes of the metal worker is most pernicious, that is the simple hanging lamp without ornament or fitting of any kind. We are not altogether in sympathy with the metal worker on this score, for we have seen most charming effects wrought by a few pendant lamps, mere frosted globes at the end of a cord. Such arrangement gives, or ought to give, a most uniform diffusion of light, and in many places it is quite at one with the simplicity of the surroundings. In this respect it is interesting to record the opinion of Sir David Salomons, who, besides giving his views on the subject, has been good enough to furnish us with two examples of lighting as practised at Broomhill, Tunbridge Wells. It was not without a good deal of experiment that Sir David Salomons came to the conclusion that pendant lighting gave the best general illumination; ground glass lamps were found to give more light over the whole area than clear glass; it was also found at Broomhill that the most serviceable position was 8 to 10 feet from the ground. We give an illustration of the drawing room at Broomhill, which clearly shows the method adopted. It is not necessary to have any special knowledge on art matters to say that this is probably the most simple and effective arrangement possible. The drawing room which we illustrate is about 30 × 20 feet, and is lighted by six 16-C.P. lamps with frosted globes. Considering the size of the room, it says a good deal for the divided method, that such few lamps are considered sufficient for the lighting purposes.

We shall not go so far as to say that pendant lighting is adapted for all places; indeed, a most cursory examination of our illustrations will show that under some of the conditions there represented, it would be inadequate, and out of place. Probably Sir David Salomons was one of the first, if not the first, to appreciate this method of lighting; certainly it is one that has been copied extensively, and very often with great success. Of course such methods do not help the trade in art metals, so we learn from the opinion of one noted in the trade. While admitting the advantages of a system of divided lighting, he condemned the almost universal use of pendants; he was, however, consoled by many indications that the public taste was improving in the matter of utilising art metals for electric lighting fittings, and he considered that, except for special positions, pendant lighting was doomed.

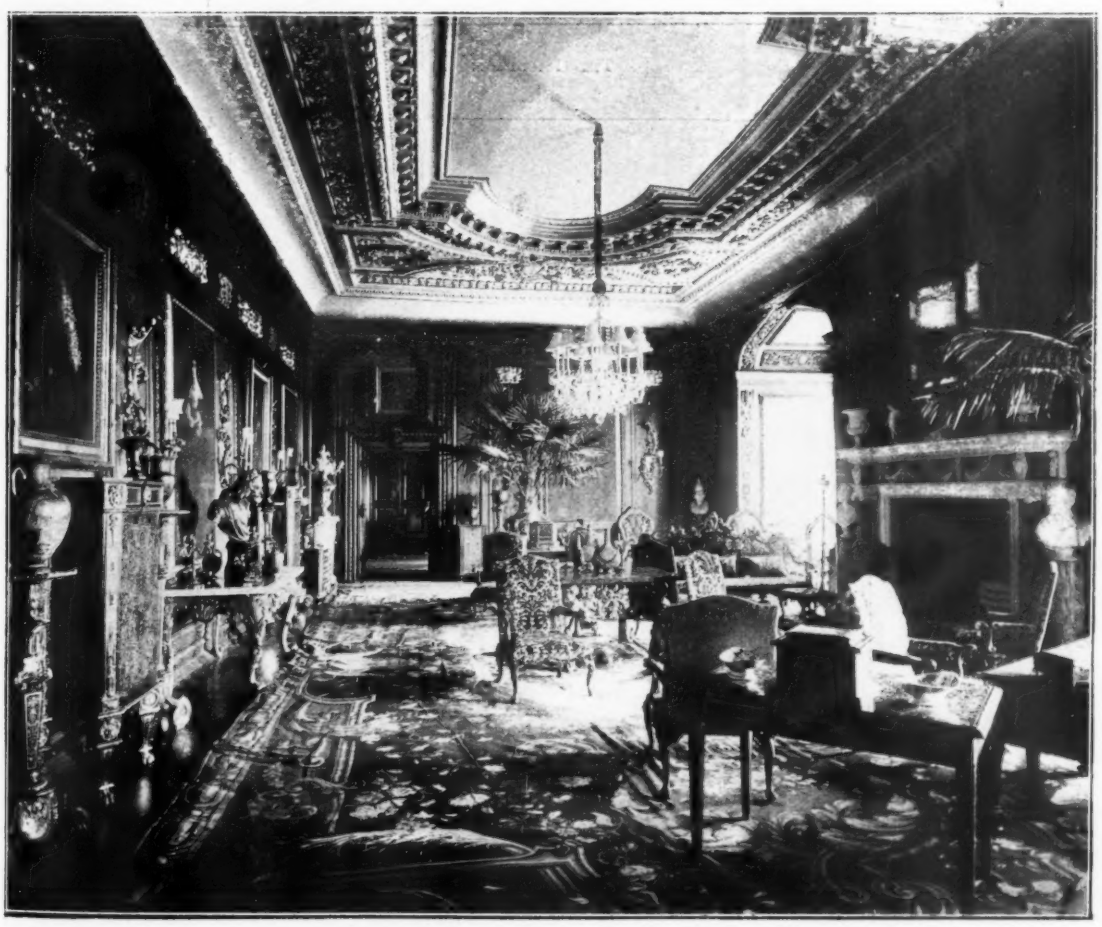
The second room which Sir David Salomons has allowed us to illustrate is the one set apart for his collection of sculpture. This room is illuminated in an exceedingly novel manner. The centre is lighted by five pendants, 16 C.P. frosted lamps; the side gallery (which is the particular portion of the room we illustrate) has one such lamp, and a small chain of 6-volt lamps held by two bronze figures suspended from the ceiling. In this room there is also a reflecting lamp for the pieces of statuary. It is interesting to mention that in this room there are connections for direct

Drawing Room, Broomhill.

Great Hall, Warwick Castle.



Statuary Room, Broomhill.



Cedar Room, Warwick Castle.

The Guildhall.

The Library, Monkhams.

HOUSES OF PARLIAMENT.—CENTRAL HALL.

THE ARMOURY PASSAGE, WARWICK CASTLE.

and alternating currents for producing various effects with vacuum tubes when desired.

As an example of lighting by central lights or chandeliers, we cannot do better than put forward the exceedingly fine specimens which are in the Council Chamber of the Guildhall and in the Central Hall of the Houses of Parliament. The effect, when the whole of the lamps on the chandelier in the Guildhall are lighted, is exceedingly good, though it has been found necessary even with the enormous amount of light emitted from the chandelier, to help the illuminating effect by side brackets and standards. There are about 80

A French Bronze.

lamps on the chandelier, and a number of small lamps placed round the galleries.

The chandelier in the Central Hall of the Houses of Parliament is, perhaps, the finest which exists in this country. It is made of brass, and weighs some 15 cwt., it being necessary to raise and lower it by means of a special crane fixed in the dome of the building. There are on this chandelier some 92 lamps of 8 C.P., and when the whole are lighted, the illumination is distinctly good. It is interesting to mention that the photograph of the Central Hall, from which our illustration has been made, was taken by the light produced from the lamps on the chandelier. It would, of course, have been possible to obtain a photograph of the Hall by daylight, but in order to show the chandelier it was necessary to have the lights burning; this fact will account for the somewhat curious blurred effect which is seen round the fitting.

St. Stephen's Hall is lighted by means of three large chandeliers or electroliers, each of which has several clusters of lamps. It is not until the lamps are burning that one gains adequate idea of the noble proportions of this hall. It is interesting to mention that the fittings shown in our illustrations of the Houses of Parliament have been adapted from old gas fittings, having been relacquered, and

A French Bronze.

in some cases undergone small improvements. They are extremely elegant, and like similar fittings at the Guildhall, have been arranged for electric lamps with remarkable success.

A similar method of lighting is that of the Banqueting Hall, Guildhall, where the fourteen artistic old chandeliers have been most effectively turned into electroliers. These fittings are practically composed of three rings, round which the lamps are placed. Each fitting carries about 48 lamps, so it may be gathered that the total illumination of the Hall is considerable. Neither the walls nor the ceilings of the Guildhall have, however, much reflective power, and it needs very many lamps to be alight before a really brilliant effect

is produced. It would be exceedingly difficult to suggest any improvement in the method of lighting those portions of the Houses of Parliament and the Guildhall which we illustrate. Illumination from the side walls is almost out of the question; a broad general lighting effect is required, and this would be almost impossible from the side. There seems to be no better way for lighting large halls than that employed both at the Guildhall and the Houses of Parliament.

The most effective and, at the same time, the most interesting illustrations which we are able to give, are those of Warwick Castle. At the outset we should like to express our thanks to Lord Warwick for permission to photograph the various rooms. Apart from the special form of lighting which the apartments have necessitated, they are, of course, interesting for many reasons, which we, in the scope of this article, cannot dwell upon. The whole of the Castle is lighted by electricity, including outer offices and so forth, there being about 550 lamps of varying candle-power. Everybody knows that Warwick Castle is famous for its State rooms, and of some of these we have been able to secure views, which clearly show the manner in which the lighting is done. First and foremost we place the famous Great Hall, containing one of the finest collections of armour in existence. The lighting is done for the most part by means of standards placed round the walls, and in other positions in the hall; these have, however, been so carefully covered by silk shades, that our readers may find a difficulty in finding them in the illustration. Suspended from the centre of the vaulted ceiling is an elegant pendant, which carries 54 small lamps, imitating as nearly as possible the candle flame; they are arranged in clusters, and give no doubt a fair distribution of light. It was highly desirable that, where possible, the

French Bronze Figures (Cottin).

original lighting fixtures should be retained, consequently in the Cedar Room the electric light is again compelled to hide its identity under candle shades. The lighting of the Cedar Room, however, is most effective; indeed, we have seen no

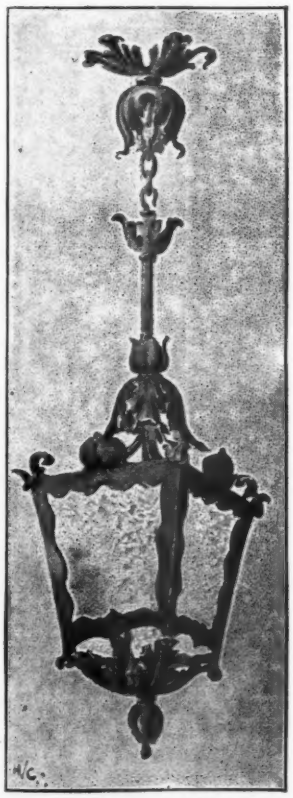
Wadham College, Oxford.

arrangement of lights which seem better disposed to give a soft and uniform illumination. It is a characteristic feature of the whole of the lighting of Warwick Castle that the filaments of the lamp are wholly prevented from falling on the eye and producing the optical effect, aptly termed

Centre Electrolier (General Electric Company).

"red hot hair-pins." From the gilt dining room we have been able to secure a view which shows a novel and effective method of lighting. It will be seen from the illustration that on each side of the fireplace stand two figures which hold branches, on which the lamps are placed. This is obviously an adaptation of an old fitting, the beauty of which has been by no means impaired by it being used for electric lighting. The Countess of Warwick's boudoir provides a

Canting Pendant (General Electric Company).



Outside Lamp (General Electric Company).

real example of the delicate and artistic effects that can be wrought with the electric light. We have thought some

interest attached to the lighting of what is called the armoury passage at Warwick Castle. Here are collected arms of all nations and of all times; to light them effectively and suitably required some consideration. To our mind the lanterns in imitation of an old style are singularly appropriate, and in perfect accord with the curious surroundings. In all other respects the fittings used in Warwick Castle are in perfect unison with the special character of the various apartments. It is necessary to mention that the whole of the lighting has been carried out by Messrs. Edmundsons, including the laying down of the generating machinery, which include gas plant and water turbines.

The Night Watchman (Tardrew, Thomas & Co.).

The picture gallery of Bell Moor, Hampstead, perhaps comes nearest to an ideally lighted room. The points of light are so well balanced, that when the room is entirely lighted it would be next to impossible to obtain harsh shadows. The lamps, it will be noticed, are placed in shapely cut glass shades, which, while cutting off very little light, prevent what Dr. Fleming aptly calls "direct visibility." As we have already pointed out in the course of this article, the first thing to aim for in a well lit room is to prevent the light falling direct on the eye; the mere fact of attempting this will lead to further artistic effects. Although such a wonderfully good effect is produced, or ought to be produced at Bell Moor, the fittings are most simple in their character. They were made by Messrs. Oslers, and it is by the courtesy of this firm that we are enabled to reproduce the illustration.

Another example of good and simple methods of lighting is that employed in the library at Monkhams, which has been designed and carried out by Messrs. H. & J. Copper. Here, again, the best effects are obtained with comparatively little display. Some variation from the method of lighting ordinary apartments is necessary in a room of this character. It is not so imperative to have a uniform distribution of light throughout a library as to have some concentration on those portions of the room usually selected for reading; this, at any rate, seems to have been the guiding principle in lighting the library at Monkhams. The lights droop from side brackets fixed in the wall, and on the ornamental mantelpiece two lamps have been placed, this arrangement giving a good general illumination on either side of the fireplace.

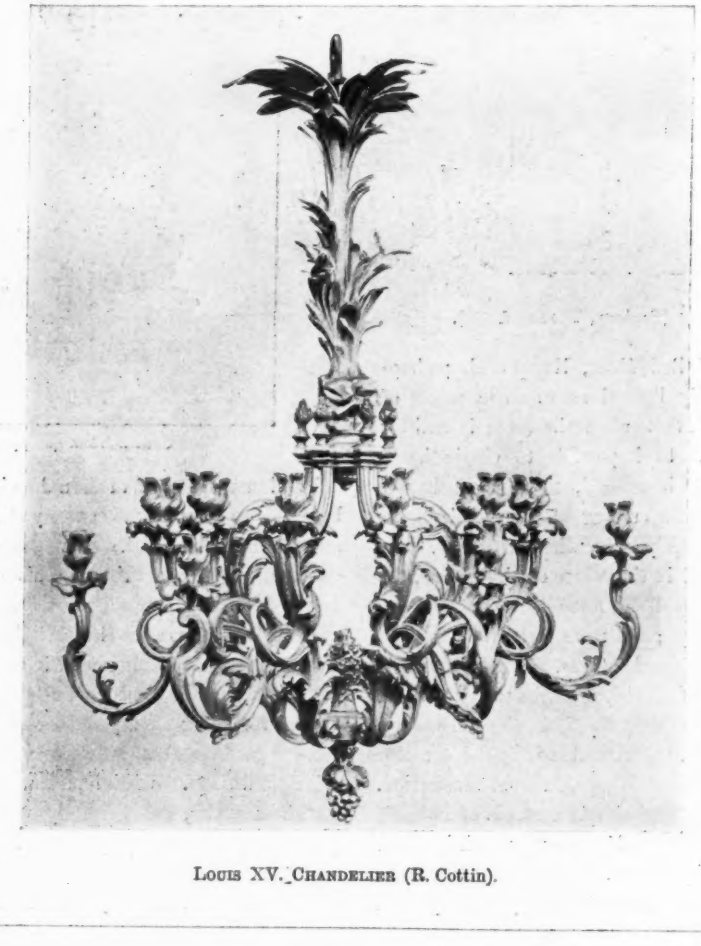
Candelabra (Perry & Co.).

The illustration of a modern drawing room, which we have been able to show by the courtesy of Messrs. Laing, Wharton and Down, concludes the illustrations of the practical application of electric lighting. This enables us to show the easy adaptation of an old glass candelabra to more modern needs. In this case the electric light has been arranged to the form of shaded candles, and, in so far as the adaptation is concerned, may be considered a success.

The foregoing examples bear eloquent testimony to the general good taste that is exercised in the arrangement of electric light fittings. We could, if it were necessary, produce some garish examples, but, generally speaking, an artistic feeling pervades those who employ electric lighting in their homes. In electric light fitting, as in many other subjects which lend themselves to artistic treatment, there is an extraordinary difference of

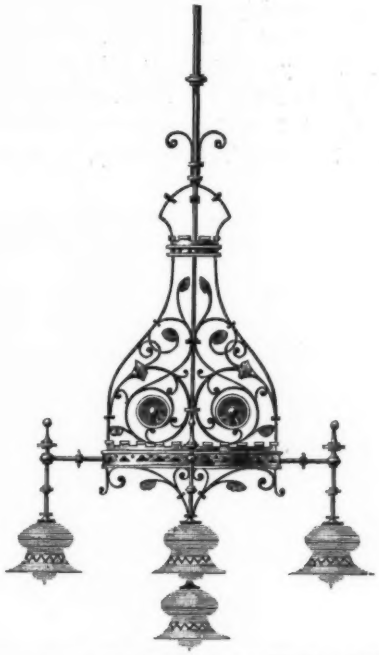
"La Breeze" (TheCrew, Thomas & Co.)

Louis XV. Bracket (R. Cottin.)



Louis XV. Chandelier (R. Cottin).

opinion on what constitutes good methods. Elaboration, as exemplified by the Florentine style, defines the position of some, while simplicity, as shown in the single unornamented pendant lamp, describes the attitude of others. Between these extremes there is great scope for designs which can be at once chaste, elegant, and uncommon. It will be interesting, then,



Electrolier for Church Lighting (Benham & Froud).

if we devote a short space to a consideration of some of the latest designs in metal work. It cannot be denied that electric lighting has helped the metal worker considerably. We do not say that he has had to improve his designs as a consequence, but we will say that it has given

A Picture Light (Benham & Froud).

him an opportunity of putting forth both design and workmanship which were unappreciated before the era of electric lighting.

The influence exerted on the design of fittings by the already mentioned amateur decorator has been considerable. It had its result in inartistic fittings made up of copper and brass, and some poor attempts at imitating floral effects. In he opinion of the worker in art metals, however, we have now reached the iron age, the designs in beaten iron being numerous and beautiful. Brass work retains a strong hold on the popularity of the public, and in the course of gathering material for this article, we have seen some really excellent specimens made in this metal. It has struck us, however, that many cleverly designed fittings had the fault of being too heavy. We do not quite know what is responsible for this; but in our opinion it is perhaps the most serious blemish in English designs. Not that we would have it thought that all English fittings have this drawback; indeed, some of the drawings which we give herewith are excellent specimens of combined elegance and lightness. At the same time, if English art metal workers are not too prejudiced, they may obtain some extremely useful ideas from the best

Bronze Figure of "Lightning" (Tardrew, Thomas & Co.)

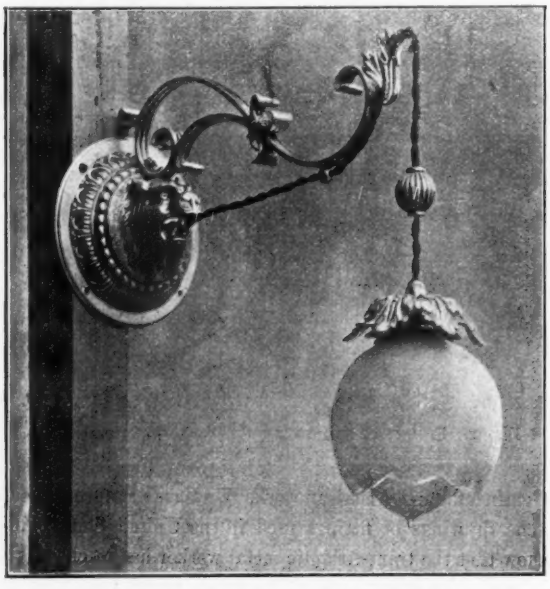
Continental and American work. We have seen, from time to time, drawings of fittings used in the United States which show that the trans-Atlantic metal worker has reached a rare degree of excellence. The American metal worker is untrammelled by traditions and old candelabra, and this may account to some extent for his unconventional but generally artistic treatment.

It has been said that the electrician knows nothing about the artistic arrangement of lighting. However much this reproach may have been merited some years ago, there are certainly electrical men who have earned great reputation as

designers both of fittings and of good methods of lighting. It is one thing to design a fitting, but quite another to place it in the most suitable surroundings. We have frequently seen most excellent work discounted by incongruous arrangement.

Italian 3-Light Bracket (Waltham Engineering Co.).

The one great complaint that we hear from art metal designers is, that their best work is copied by somebody else. Curiously enough, the complaint does not proceed from two or three firms, but nearly everybody in the business makes the



Library Fitting, Italian Style (Messrs. Strode & Co.).

allegation; indeed, so unanimous is the opinion, that it becomes a difficult matter to say who are the culprits. Even the trite saying that appropriation is the sincerest form of flattery has no consoling power with the wronged metal worker. But as the trouble is so universal, it might be so easy for all the metal workers to come together and agree not to take each other's good things.

Coming to consider more in detail the special fittings, perhaps one of the most striking is that designed by Messrs. Benham & Froud for the Bayswater Synagogue. It will be seen that the design is distinctly Moorish in character, and we understand that it harmonises well with the character of the building. Certainly it corresponds perfectly with the general metal work of the Synagogue, of which there is a good deal. This type of fitting is one that has been extensively employed by Benham & Froud, and there seems every indication that it is a class of fitting likely to become popular. If it is a mark of popularity, we might say that

Louis XV. Standard (Waltham Engineering Co.).

the design has even been adopted on a Thames houseboat—a somewhat curious place to find Moorish fittings.

The General Electric Company have been recently paying some considerable attention to the design of fittings, and we are enabled to give two or three of their specimens. They are making a dining room pendant which demands some notice, not alone by reason of its elaborate character, but because it has an exceptionally good arrangement for raising and lowering. This is accomplished by a special form of counterweight enclosed in the centre case, yet it is comparatively light, and is eminently suitable for a dining room. Of the fittings which we illustrate of this firm it is not necessary to say much, except to draw attention to the well devised outside lantern done in beaten iron, and a further elaboration of the canting pendant.

In the application of fine art bronzes to electric lighting work, it must be confessed that English metal workers have accomplished little. It is not that there has been no demand

for such work; indeed, quite the reverse has been the case. Whatever may be the reason of the failure of Englishmen, it is certain that for much of the artistic work in bronze we have had to avail ourselves of French productions. Nor was it easy until quite recently to obtain even French work. With the establishment of one or more French bronze firms in London, however, much of the former difficulties have disappeared. The result of being able to obtain these bronzes readily has been their immediate and ready adaptation to electric light fittings. The finest collection of French bronzes, specially designed for electric lighting, to be found in London, is at the branch establishment, at 75, High Holborn, of R. Cottin, a well known Parisian bronze founder. We recently had the pleasure of examining M. Cottin's collection, and were charmed with the artistic feeling exhibited in the design, and the extreme delicacy of finish which characterised most of the bronzes. With the help of M. Cottin, we are able to illustrate a candelabra of the period of Louis XV., which is designed for 18 lights, and a small Louis XV. bracket, intended to carry six lamps. It is interesting to mention that the latter is an exact reproduction of the bracket ornamenting the Salle des Fêtes of the Château de Chantilly. Perhaps the most striking feature about the French bronze work is the great merit which marks the statuettes. Although we have been able to obtain good reproductions of the various figures, they must necessarily suffer somewhat in the various processes previous to printing. There is still retained, however, the grace of form, the elegant pose, and to some extent the exquisite finish which characterise the original figures. The statues of the vase carriers have been designed by M. Cottin especially for the English market.

It is not surprising that the introduction of French bronzes into England has met with great success; indeed, we should have been surprised had it been otherwise. Many of the figures are singularly appropriate for electric lamps, and when in harmony with surrounding conditions, are artistic in the highest sense of the word.

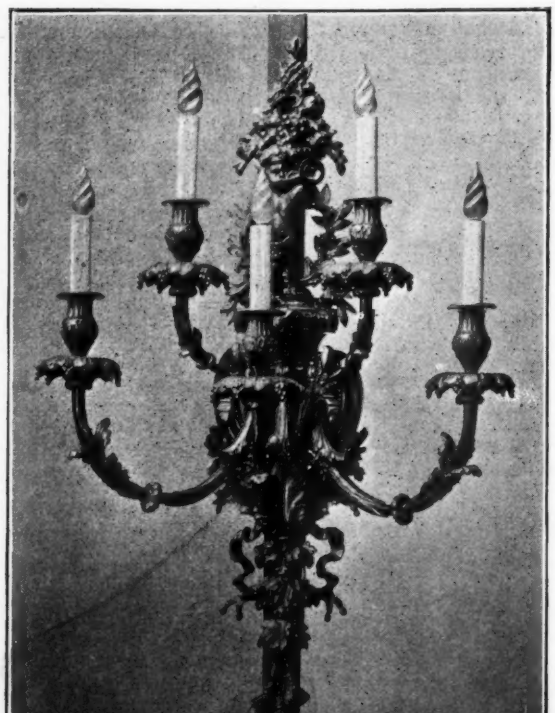
Though we leave to the last the consideration of the French bronzes introduced into England by Messrs. Tardrew, Thomas & Co., St. George's Avenue, Aldermanbury, it will be seen from the examples which we give that they are exceedingly beautiful. Indeed, we feel the difficulty of doing them adequate justice. We illustrate the statuette, "Lightning," which has been modelled by Steiner; it is designed to carry three electric lamps. The idea has been well conceived, and excellently carried out. The statuette "La Breeze," is after a model by Nelson, and is made to hold two electric lights. While, of course, the idea of the night watchman is not altogether new in electric light fittings, the statuette of Messrs. Tardrew, Thomas & Co., designed by

Newal Standard.

Central Electrolier, Bayswater Synagogue.

Picault, is well finished. All these figures can be obtained in almost any colour; they are usually made of French compo-bronze, but are also made in real bronze, the price of the latter being about one and half as much as the compo-bronze.

One of the most effective methods of shading incandescent lamps is by means of shades composed of feathers. They are light and graceful, and add wonderfully to the decorative quality of the electric light. These shades were put on the market about a year ago, and so far as we can learn, where they became known, they have been appreciated. It is not, however, until the light is turned on that one can properly value their wonderful toning effect; they are dyed in many



5-Light Gilt Bracket, Louis XVI. (Messrs. Strode & Co.).

colours, and there is practically no end to the various effects that can be produced.

We illustrate two designed to suggest roses, and another design which is specially used for lamp standards. The shades are in most cases intended to simulate flowers, the most successful ones being the water-lily, the tulip, the fuchsia, and the rose. The designs are chiefly by Miss Beatrice Devonport, who is to be congratulated on the merit of her productions. Messrs. Roger Dawson, Limited, have sent us a sketch of a Newal fitting in the Adams style, which has been lately designed and manufactured by them for Mr. Jameson's new mansion in Dublin. We understand that the fittings for this building were exceedingly costly, every-one being specially designed to match existing decorations.

We have referred in previous numbers to the excellent metal work made by the Waltham Electrical Engineering Company, we give herewith two designs of this firm, the 3-light bracket being in the Italian Renaissance style, and the standard in style of Louis XV., both being good examples of highly-chased cast-work.

Both the foregoing and the next example of metal work of which we are about to speak are exceedingly creditable to English work. The specimen which we illustrate of Messrs. Perry & Co. represents one of the four grand bronze candelabra, standing 10 feet high and weighing ¼ ton each, which were made for the late Mr. H. Brassey in 1891, and which have been presented to the Imperial Institute, South Kensington. These candelabra are reproductions of Rennaissance work formerly in the Church of the Convent of St. Mark's, Milan, but which were sold in 1870 for the benefit of the fund for the restoration of the roof of the church.

We illustrate two or three specimens of Messrs. Osler's work.

NOTES.

An Electrolytic Disruptive Effect.—In the *Journal* of the Franklin Institute, Mr. C. J. Reed describes an effect which he first observed when a current, passing under a high electromotive force, by means of lead electrodes, through a solution of acid sodium phosphate, is broken by the removal of the cathode from the solution. At the moment of final contact, he observed what appeared to be a cloud of smoke passing from the cathode into the electrolyte. He afterwards found that by exposing only a very small surface of the negative electrode to the solution a voluminous cloud of dark blue or lead-coloured precipitate was obtained. From subsequent tests, it appears that this precipitate was simply lead in a condition of fine sub-division. A similar effect is obtainable in the case of a cathode of metallic arsenic; a brown film of arsenic hydride being formed. The explanation of the observed phenomena is doubtless that, in the case of metals possessed of little tenacity, particles are torn from the electrode by the hydrogen gas violently disengaged from its surface. Thus it was found that no precipitate or film was formed in solutions from which a metal can be deposited by electrolysis. In the case of a solution of strontium nitrate, an entirely different phenomenon was noticed; instead of the lead powder, a blue flame appeared around the point of the lead cathode.

Obituary.—We much regret to announce the death of Mr. G. M. Phelps, of the New York *Electrical Engineer*. Mr. Phelps was the son of an electrician of repute. He was born in 1843, and was engaged in practical electrical work in the employment of the American Telegraph Company in 1861. He was later connected with the Western Union Telegraph Company, and finally became superintendent of the New York factory of the Western Electric Company until 1885, when he quitted practical work for technical journalism. His qualifications for such an undertaking, by his experience and tastes, have been amply testified by the career and character of the *Electrical Engineer*, of which he was the guiding spirit. He was president of the company owning that journal, and was identified with many electrical associations in the United States, but was not largely known personally amongst English electricians. Those, however, who had the pleasure of his acquaintance will mourn his death as the loss of a genial companion or a trusted friend—one who sought neither popularity nor personal aggrandisement. Since its publication as a weekly journal, the *Electrical Engineer* has been under the editorship of Messrs. Martin and Wetzler, who will continue to control it, we do not doubt, with the ability and success which it has hitherto received.

The Royal Society.—Before this Society yesterday afternoon, a paper was read by Dr. Hopkinson, F.R.S., and E. Wilson on "Alternate Current Dynamo-Electric Machines."

Société Internationale des Electriciens.—The general meeting of the society took place April 3rd, 1895, with M. Postel-Vinay, the retiring president, in the chair. M. Potier was appointed last year as president for the session 1895-6, but he is in ill-health, and will very often be unable to fill the position. This year's elections gave the following results :—President for 1896-7, M. G. Sciama ; vice-presidents, Messrs. Violet and Violle ; secretaries, Messrs. Boucherot and Janet ; general secretary, M. Hillairet. Members : Messrs. Aylmer, Bélugou, Boistel, Chaperon, Clémanzon, Ducretet, Harlé, Labour, Lippmann, Marey, Ménier, Meyer, Pellat, Poincaré, Sarcia, Sartiaux, de la Touanne. During the meeting, M. Arnoux read a paper on the new aperiodic ampère-meters and voltmeters, which he constructs jointly with M. Chauvin. These instruments are aperiodic and highly sensitive. They consist in principle of a bobbin of insulated copper wire held between two concentric copper rings. Springs hold the bobbin at the two extremities, it moving between pivots. In the centre is a sphere of fixed iron which serves to concentrate the magnetic field. The whole of the movable part is placed in a very intense magnetic field between the arms of a tungsten steel magnet without pole pieces in relation. The aperiodic properties are what is most noticed about these instruments. The movable part when withdrawn from the magnetic field oscillates considerably, but when it is placed in the field all the oscillations immediately disappear. M. J. Sarcia spoke of electric traction by accumulators. He mentioned the various modifications that have recently been introduced into this mode of traction. All the accumulators are enclosed in a single case, which is suspended under the car between the two axles. The electromotors to be employed will be shunt motors. Lastly, he stated that the cost per car-kilometer, obtained from a sum total of 803,293 car-kilometers, was ·542 francs with accumulators, whereas with horses it was formerly ·557 francs.

Platinum.—An American journal, in an article regarding the production and uses of platinum, says that the Ural platinum deposits in Russia are the only ones in the world, as this metal is worked nowhere else, and is known simply as a mineral finely disseminated in certain rocks. In the district of Goroblagodat there are 70 allotments for the exploitation of platinum under different private individuals. The metal is found in the form of alluvial deposits or platinum-bearing sands, which frequently also contain gold. The platinum is frequently accompanied by other rare metals, such as iridium and osmium. At present all the platinum extracted in the Urals is forwarded in the crude state to St. Petersburg, whence it is sent abroad. Although there are two laboratories in the Russian capital for refining platinum ore, the greater quantity is sent abroad in the crude state. Although the first platinum deposits in Russia were discovered so far back as 1819, the actual exploitation of this metal began only in 1824, when rich veins were discovered in the Nizhni-Tagilsk district. The value of the yearly export of platinum, which comes chiefly to England, is about 1,560,000 roubles. The largest quantity of platinum is now extracted at the deposits of Nizhni-Tagilsk, belonging to Prince Demidoff San Donato, and at the Krestovosdvigensk deposits of Count Schouvaloff. In 1890 there were 6,000 workmen employed in the exploitation of platinum.

A Voltaic Couple of High E.M.F.—In the laboratory of Mr. Desmond FitzGerald, the following voltaic combination was recently tested. The positive element was a plate of aluminium ; this was immersed in a solution of caustic potash. The negative was a carbon plate, in contact with strong nitric acid contained in a porous pot. The initial electromotive force of this couple was found to be 2·8 volts. The cell is, of course, not adapted for ordinary use, by reason of the cost of working it ; but it is of interest from a theoretical point of view.

Ozone.—Now that the question of producing and utilising ozone is attracting some attention, it may be interesting to point out that, in 1884, Dr. Wise constructed a machine for the manufacture of this substance on a large scale, for use in a health resort under his charge in the Engadine ; 38 tinfoil plates were used in it, and air was driven through it by means of a turbine.

Operating Canal and River Locks by Electricity.—Within the last few years it has been found necessary to build new locks alongside the existing locks (at Ymuiden), in Amsterdam, in the canal which connects the city with the North Sea. These locks are now nearly completed. It will be remembered that in June, 1893, plans were invited for hydraulic and electric transmission of power for operating the locks. Of the plans sent in, four—two based on hydraulic, and the other two on electric transmission of power—were purchased. It was, later, found that none of these plans fulfilled the required conditions, and the senders were invited to submit revised plans. The result of the subsequent comparison was that Messrs. Figee Brothers, manufacturers of hoisting machinery, Haarlem, and Messrs. P. H. Ter Meulen and Co. (representatives in Amsterdam of Messrs. Schuckert and Co.), were invited to conjointly make the preliminary trials at Ymuiden. These trials will consist principally in measuring exactly by electric machinery the power required to open the doors of the new locks. In a temporary shed, in close proximity to the locks, the necessary boilers, engines, and dynamos will be placed to generate the electric current. This current will be carried through overhead cables, and will be used to turn two capstans, having a force of 5,000 kg. by 20 cm. and 10,000 kg. by 10 cm. velocity per second. It is almost certain that in this case electricity will prove to be a formidable rival to the hydraulic transmission of power, heretofore almost exclusively called to aid for the operation of locks. To this proposed installation also belong large storage batteries, powerful enough to act as auxiliaries in operating the locks for a certain length of time, should emergency require it. The joint plan was designed by Messrs. F. C. Dufour and J. F. Hulswit, engineers of the above-named firms. The results arrived at from these trials will determine the exact size of the machinery required for the operations of opening and closing the different doors.

Argon.—In his recent Friday evening lecture before the Royal Institution, Lord Rayleigh used two wall diagrams for the purpose of illustration, from which we take the following figures :—

I.—Characteristics of Gases.

Name of the gas.	Freezing pressure.	Critical temperature.	Critical pressure.	Boiling point.	Freezing point.	Density of gas.	Density of liquid gas.
*Hydrogen H_2 ..	..	Below −226°	20 atmos.	..	..	1	..
*Nitrogen N_2 ..	60 mm. Hg	−146°	35	−194°	−214°	14	·885
*Carbonic oxide C O	100	−139·5°	35·5	−190°	−207°	14	..
*Argon A_1	..	−121°	50·6	−187°	−189·6	19·9	about 1·5
†Oxygen O_2 ..	..	−118·8°	50·8	−182·7°	..	16	1·124
*Nitric oxide N O	138	−93·5°	71·2	−153·6°	−167	15	..
*Methane C H_4 ..	80	−81·8°	54·9	−164	−187·8	8	·415

* Colourless. † Bluish.

II.—Nitrogen, Density.

Atmospheric Nitrogen.

By hot copper, 1893	2·3103
„ iron, 1893	2·3100
By ferrous hydrate, 1894	2·3102
Mean	2·3102

Chemical Nitrogen.

From nitric oxide	2·3001
„ nitrous oxide	2·2990
„ ammonium nitrite (purified at a red heat) ...	2·2987
„ urea	2·2985
„ ammonium nitrite (purified cold)	2·2987
Mean	2·2990

Lectures.—At a conference of Vestrymen, convened by the London Reform Union, and held at the Club Union Hall, Holborn, a paper was read on Tuesday by Prof. Henry Robinson, C.E., his subject being, "The Generation and Distribution of Electricity by Local Authorities."

On May 14th, at the Royal Victoria Hall, in Waterloo Bridge Road, S E., Prof. J. A. Fleming, F.R.S., will lecture on "Electric Tram Cars."

Storage of Energy.—The following letter, replying to that which we published in our issue of 12th ult., has been sent to the New York *Electrical Engineer* by Mr. Nelson W. Perry:—"It is with considerable temerity that I offer again to the public my views upon any subject after reading in your last issue the authoritative opinion of Mr. Herbert Lloyd that Mr. Perry is not a man of ordinary intelligence, and that his statements are not only ridiculous, but *false*. Mr. Lloyd clinches his argument by stating that I cannot distinguish the difference between a horse-power and a horse-power-hour. This leaves me without a leg to stand on, but while admitting my weakness, and that I am no match for Mr. Lloyd in gentlemanly controversy, acknowledging a complete knock-out, I still beg to restate my position. In the preparation of my paper read at the Cleveland Convention of the N. E. L. A., all available information was gathered as to the original cost and expense of maintenance of central station storage battery plants both here and abroad. Most of my conclusions were based on figures given by the Electric Storage Battery Company of Philadelphia, of which Mr. Lloyd is the general manager. I believed them to be essentially correct. Among other things, Mr. Lloyd charges that my figures of original cost were too high, and that his company are willing to take contracts at much lower rates. If Mr. Lloyd will now publish this revised price list, with discounts for plants of various capacities, and with the specific guarantees which his company will make for each, I should regard such statement as authentic, and gracefully acknowledge my error if his prices prove to be lower than those given by me. It is on record that the price on one plant sold by Mr. Lloyd's company since the Cleveland meeting was *higher* than the price assumed by me. Mr. Lloyd still clings to the idea that Mr. Edgar's statement in regard to the battery plant purchased by the Boston Edison Company refutes my views and substantiates his position; whereas Mr. Edgar's explanation was accepted by every intelligent central station man at the Cleveland meeting as *proving* that the only place for a battery plant in central station service is in taking the peak off the load line. This was and is my exact position."

The Preparation of Argon.—M. Guntz describes a simple method of showing the presence of argon in atmospheric nitrogen. He puts a small crucible of lithium into a tube containing nitrogen, and gently heats the crucible. The nitrogen combines with the lithium, and a partial vacuum is produced in the tube, the pressure of the residual gas corresponding to about 10 millimetres of mercury. If atmospheric nitrogen is again introduced into the tube, and the crucible again heated, the nitrogen is once more absorbed by the lithium; but this time not so completely, the residual gas exerting a pressure corresponding to about 20 millimetres. After repeating the experiment a large number of times, it is found that the proportion of gas not absorbed by the lithium increases at every experiment, and eventually the apparatus becomes filled with argon. To show that the residual gas is due to the presence of argon, and not to the non-absorption of nitrogen by the lithium, M. Guntz suggests that the experiments described be repeated with nitrous oxide instead of atmospheric nitrogen. It will then be seen that the vacuum obtained in the first experiment is maintained throughout. In preparing argon, it seems, all that is required is to form a stream of atmospheric nitrogen through a tube containing lithium, the latter being subjected to a gentle heat.

The First Electrical Clinic in America.—The formal opening of the first electrical clinic in America, "The New York Electro-Therapeutic Clinic Laboratory and Dispensary," at No. 327, East Twenty-fifth Street, New York City, took place on Saturday evening, April 6th. It has been founded, states our American namesake, by Dr. Margaret A. Cleaves, for electrical treatment of charity patients in all cases traceable to malnutrition.

Deposition of Cuprous Oxide.—When a solution of sulphate of copper is raised to boiling heat, the deposit at the cathode is, as Dr. H. Hammerl has pointed out, almost entirely composed of cuprous oxide. It is probable that a useful and handsome preservative coating might in this manner be applied to certain metals.

Electric Light Mains.—In Mr. Kingdon's letter, p. 534, he says that two at least of the figures in Grant's complete specification appear to be modifications of his (Kingdon's) ∩ channels, and that there is no reference to these in Grant's provisional. It seems to us that Mr. Kingdon is mistaken, for we cannot see that Mr. Grant has in any of his figures gone beyond slight modifications of his semi-circular or three sides of a square construction, as mentioned in his provisional specification.

Fire Rules.—The Institution of Electrical Engineers has formed a technical committee for the purpose of revising the old rules, and, if necessary, suggesting new ones for house wiring. It is not necessary to say much about the reform that is needed, the fact that the Institution has recognised it speaks volumes. But no fire rules will be of any real avail until a more efficient and rigorous system of inspection is adopted.

Three-Wire Lighting Plant.—We are indebted to the courtesy of Mr. W. M. Stine, of the Armour Institute, at Chicago, for the article on this subject which appears elsewhere in this issue.

The Institution of Electrical Engineers.—By permission of the Society of Arts the institution meets at John Street, Adelphi, on Thursday, May 9th, at 8 p.m., when a paper will be read "On the Recent Development of the Single-acting High-speed Engine for Central Station Work," by Mark H. Robinson, member.

The Lighting of Schools.—The Manchester and Salford Sanitary Association, the other day, had a paper read before it by Dr. A. Emrys-Jones, on "The Lighting of Schools." He strongly recommended the use of electric light in all schools.

Fires Made Easy.—The joints we illustrated on p. 502 last week have been productive of more samples of a similar kind, about which we shall, doubtless, have something to say in our next issue. In the meantime we shall be glad to receive any further information on this subject from any of our readers who have had to overhaul such scamped workmanship.

Royal Society Soirée.—The annual soirée of this society was held on Wednesday evening.

CONTRACTS OPEN AND CLOSED.

OPEN.

Brazil.—The municipal authorities of Saint Jean-del-Rey, Brazil, are at present inviting tenders for the electric lighting of the town.

Brighton.—May 13th. The Borough Council are inviting tenders for India-rubber lead-covered cables.

Brighton.—The Brighton and Rottingdean Seashore Electric Railway Company invite tenders for accumulators for use on a large car.

Brighton.—May 13th and 27th. The Corporation invite tenders for arc lamps, &c., and boilers.

France.—May 25th. The Prefecture of Saint Lô, at Cherbourg (Manche), is inviting tenders for the operation of electric tramways in Cherbourg.

Holland.—June 1st. The Dutch Telegraph Department in Amsterdam is inviting tenders for the supply of 600,000 kilogrammes of paper slips for Morse telegraph instruments.

La Plata.—The La Plata Telegraph Department is calling for tenders for supply of telegraphic materials.

Londonderry.—June 1st. Tenders are being invited by the Corporation for carbons. Details to be obtained from the town clerk, Mr. R. Chambers, at the Guildhall.

Manchester.—May 13th. Tenders are invited for the supply, delivery, and erection, complete, of the electric lighting machinery and installation for the efficient lighting of the new foreign animals wharf at Mode Wheel, for the Corporation. Details can be obtained from Mr. T. de Courcy Meade, City Surveyor, Town Hall, Manchester.

Rangoon.—November 4th. The Municipal Committee is inviting tenders for electric lighting. Particulars to be obtained from Messrs. Ogilvy, Gillanders & Co., 67, Cornhill, E.C.

Roumania.—May 11th. The General Direction of the Roumanian Posts and Telegraphs in Bucharest is inviting tenders for the supply of 2,400 kilogrammes of brass; 125 kilogrammes of copper wire; 120 kilogrammes of rubber; 150 packets of iron screws; 25 packets of brass screws; and 570 kilogrammes of weld iron.

Shoreditch.—May 20th. Tenders are invited for dust destructor furnaces for electricity supply.

Tunbridge Wells.—May 28th. The Corporation are inviting tenders for the wiring of the municipal buildings, in accordance with the specification prepared by the electrical engineer. Full particulars to be obtained from the Town Clerk at the Town Hall.

Wakefield.—We understand that tenders are to be invited for electric lighting works here.

CLOSED.

Brighton.—The tender of Messrs. J. Longley & Co., Crawley, has been accepted by the Works Committee for the extension of the Corporation electric generating station. The amount of the tender is £12,169.

NEW COMPANIES REGISTERED.

General Traction Company, Limited (43,880).—This company was registered on April 20th with a capital of £50,000 in £5 shares, to enter into an agreement with the Electric and General Contract Corporation, Limited, and to enter into, or acquire, and carry out contracts, or concessions, or other grants, in any part of the world, for making, purchasing, or working railways, tramways, telegraph and telephone lines, electric and other lighting works, electric, hydraulic, or other works, and for the equipment of any such undertakings or works with electric or other plant, stock, and apparatus. The subscribers (with one share each) are:—E. A. Hopkins, 35, Parliament Street, S.W., banker; W. S. G. Baker, 35, Parliament Street, S.W., engineer; A. de Turckheim, 35, Parliament Street, S.W., gentleman; R. B. Johnson, 49, Parliament Street, S.W., solicitor; E. T. Church, 41, Copleston Road, Denmark Park, clerk; A. W. Lawson, 3, Holly Road, Leytonstone, clerk; E. Wyatt, 11, Highbury Crescent West, N., clerk. The number of directors is not to be less than two nor more than seven; subscribers are to appoint the first; remuneration as the company may decide. Registered by Ashurst and Co., 17, Throgmorton Avenue, E.C.

Cheshire Electric and Steam Yacht Company, Limited (43,844).—This company has just been registered with a capital of £2,000 in £1 shares, to convey passengers and goods in launches, yachts, boats, and vessels, to be propelled by electric, steam, or other motive power, between such places as the directors of the company may from time to time determine, and to purchase, build, hire or charter or otherwise acquire yachts, boats, launches, and other suitable vessels, with all requisite equipments, and furniture, dynamos, machinery, engines, &c. The subscribers (with one share each) are:—J. L. Gordon, 35, Chapel Walks, Liverpool, merchant; J. Heathcock, 33, Tollemache Street, New Brighton, engineer; J. H. Barnes, 70, Victoria Street, Liverpool, engineer; J. A. Foster, 7, Redcross Street, Liverpool, broker; J. E. N. Webster, 29, Sackville, Liverpool, agent; F. P. Comber, 28, Bull Lane, Aintree, Liverpool, agent; H. Ludeke, 5, Redcross Street, Liverpool, hotel proprietor. Registered, without articles of association, by A. H. Dabbs, 33, Chancery Lane, W.C. Registered office, 7, Baltic Buildings, 9, Redcross Street, Liverpool.

Manchester Suburban Electric Supply, Limited (43,884).—This company was registered on April 22nd with a capital of £25,000 in £1 shares, to take a transfer from the Collier-Marr Telephone and Electrical Manufacturing Company, Limited, of a provisional order granted to them by the Board of Trade, authorising the undertakers to produce, store, supply, and sell electricity, electric current, and other like energy for public and private purposes; to enter into a certain agreement, and to carry on the business of electrical engineers. The subscribers (with one share each) are:—J. Nasmith, 61, Barton Arcade, Manchester, engineer; W. Wilson, 50, King Street, Manchester, engineer; F. Hadfield, 9, Demesne Road, Whalley Ranger, engineer; W. G. Thompson, Westwood, Whalley Ranger, manufacturer; J. Lawson, Withington Road, Whalley Ranger, veterinary surgeon; J. Thompson, 107, Moss Lane, West Moss Side, ironmonger; J. Nuttall, Thorney Holme, Old Trafford, contractor. The number of directors is not to be less than five nor more than seven. Qualification £100; remuneration as may be fixed by the company. Registered office, 8, South King Street, Manchester.

Electro-Hygienic Company, Limited (43,923).—This company was registered on April 26th with a capital of £20,000, in £1 shares, to adopt an agreement dated April 18th between Henry C. Braun and Henry C. B. Sharman of the one part, and Thomas O'Hare (for the company) of the other part, and to acquire, develop, turn to account, and deal with certain patents, patent rights, licenses, concessions, &c., particulars of which do not transpire. The subscribers are: Wm. J. Lancaster, Colmore Row, Birmingham, optician, 500 shares; Henry Bisselleer, 11 to 15, New Bartholomew Street, Birmingham, brassfounder, 500 shares; Joseph Hawkes, Heathfield Road, Handsworth, silversmith, 500 shares; W. L. Barber, 103, Bristol Road, Birmingham, manufacturer, one share; John J. H. Sturney, Fern Bank, Middleborough Road, Coventry, newspaper proprietor, one share; Wm. G. Anderson, 17, Dora Road, Birmingham, journalist, one share; Thomas O'Hare, 5, Hyde Road, Edgbaston, Birmingham clerk, one share. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first. Qualification 500 shares; remuneration as fixed by the company. Registered by Barlow & James, 165, Fenchurch Street, E.C.

Jandus Arc Lamp and Electric Company, Limited (43,898).—This company was registered on April 24th, with a capital of £20,000 in £10 shares, to acquire from J. B. Barton certain letters patent already granted to him in the United Kingdom for "Improvements in connection with electric arc lamps," and the benefit of all improvements in connection with electric lamps already made or to be made by John B. Barton and William Jandus, to adopt a certain agreement and to carry on the business of an electric company in all its branches. The subscribers (with one share each) are:—B. M. Drake, 66, Victoria Street, S.W., electrical engineer; T. A. Earle, 88, King Street, Manchester, land agent; E. N. Galloway, Knott Mill Iron Works, Manchester, engineer; S Garrett, The Rookery, Pendleton, engineer; J. T. Petrocokino, 6, Minshall Street, Manchester, merchant; F. Reddaway, Didsbury Lodge, Manchester, manufacturer; A. O. Gillies, 46, Brown Street, Manchester, chartered accountant. The number of directors is not to be less than three nor more than seven. The first are B. Drake, T. A. Earle, E. N. Galloway, R. M. Gorham, J. T. Petrocokino, F. Reddaway, and J. B. Barton. Qualification £200; remuneration as fixed by the company in general meeting. Registered by Payne & Co., 28, Brazenose Street, Manchester.

CITY NOTES.

Eastern Extension, Australasia and China Telegraph Company.

The forty-third ordinary general meeting of the shareholders of the above company was held at Winchester House, E.C., on Wednesday, Sir John Pender, M.P. (chairman) presiding.

In moving the adoption of the report, the Chairman said the gross receipts for the half-year had amounted to £261,322, against £251,687 for the corresponding period of 1893, showing an increase of £9,635, which was entirely due to the large government and press traffic between China and Japan since the commencement of hostilities between those countries. The working expenses amounted to £89,740, against £76,574 for the corresponding period of 1893, showing an increase of £13,166. Of that sum nearly £9,000 was due to increased cost of repairs and maintenance of cables, which was always an uncertain factor, opening of new stations at Labuan and Somabaya, and the establishment of the electric light at various stations, and other exceptional items. Comparing the figures for the whole year, the results were as follows:—the gross receipts for 1894 were £509,003, against £509,684, or practically the same as in 1893; working expenses were £170,035 against £151,803, or an increase of £18,232 as already explained. The usual interim dividends had been distributed during the past year, making with the dividend proposed to be paid the following day a total payment of 5 per cent. for 1894. It was also proposed to pay a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the past year. The balance of £89,686 had been carried to the general reserve fund, which now stood at £641,598, after charging during the past year £100,000 in part payment of the new Singapore-Hongkong cable. Altogether over 1¼ millions had been spent out of revenue since the formation of the company on cable renewals, duplications and triplications. In terms of the trust deed, a further drawing by lot of 389 of the company's 5 per cent. Australian Subsidy debentures took place on the 1st ult. for payment at par on July 1st next, when the debenture debt, which originally amounted to £640,000, would have been reduced to £209,500. The maintenance ships had, as usual, been kept busy during the past year in efficiently maintaining their extensive system, but, as most of the cables were duplicated, the revenue had in no instance been materially affected. Neither had the war in the East interfered with their cables, the service having been conducted as regularly as in times of peace. For that they were undoubtedly indebted to the friendly but strict neutrality which the company had maintained towards the two belligerents throughout the hostilities. As announced in the report, the directors had lost, in the decease of the Right Hon. Viscount Monck, an esteemed colleague, who had been connected with the company from its formation. Since he last had the pleasure of meeting them, another inter-colonial postal and telegraph conference had been held in Australia, at which their guarantee arrangements with the Colonies were fully discussed. As they were aware, the Colonies had been passing through a severe financial crisis, and with a view to retrenching as much as possible, the Government of Victoria had given notice to the other guaranteeing governments that she would probably withdraw from the guarantees at the end of the year. After full consideration, however, it was decided that the arrangements should be continued with certain slight modifications for a fixed period of at least five years, instead of being subject to cancellation at the end of any year as was previously the case. Consequently the cheap tariffs now in force between this country and Australia would remain unchanged during the next five years. It was hoped from certain remarks made by the Queensland delegate, that that colony would join in the modified arrangement, and thus enable them to charge the same reduced rates to Queensland as the other colonies enjoyed, but up to the present they had not received any definite announcement on the subject. The amount of guarantee Queensland would have to make up would be quite trifling compared with the advantages she would derive from the reduction of tariffs, and he still hoped she would see the advisability of coming

into the arrangement. The Pacific cable project was also fully discussed at the Hobart Conference, but the resolution submitted by the Queensland delegate for practically dealing with it was unsupported and withdrawn, and an amendment was subsequently passed simply reaffirming the desirability of cable communication across the Pacific, and urging the various governments to take steps to further the project at the earliest opportunity. Canada seemed to be losing no opportunity of keeping the project before the public, but until the Colonies were in a better financial position, and were agreed amongst themselves as to the details of the scheme, which was very far from being the case at present, he did not think that any real progress would be made in the matter. He thought he had put before them a most satisfactory account of their last six months' work. They occupied a very unique position, and had done their work remarkably well. They had secured the full confidence of the telegraphic public, and while not paying their shareholders an exorbitant dividend, they had paid a much larger one than paid by most companies floated within the last 25 years. They had established a thoroughly sound system, which the world could not live without, and they had never had a fault found with them by doing anything not thoroughly straight. Their policy had been to carry cables to all parts where the British flag flies, and that policy they would continue to carry out.

The Marquis of Tweedale seconded the adoption of the report, and after some remarks by Messrs. Newton and Griffith, it was carried.

Indo-European Telegraph Company, Limited.

The twenty-eighth ordinary general meeting of the shareholdrs of the above company was held at Winchester House, E.C., on Monday, Mr. J. Herbert Tritton (chairman) presiding.

The Chairman said: Gentlemen, I have to move that the report and accounts now submitted be received and adopted, and that a dividend be and is hereby declared for the half-year ending December 31st, 1894, of 17s. 6d. per share, making with the dividend already paid 6 per cent., and a bonus of 20s. per share, both free of income tax, making in all 10 per cent. for the year. It is once more my pleasant duty to congratulate you upon the outcome of the working of the company. The past year shows, it is true, a slight falling off in the bonus as compared with the year 1893. The total decrease in the traffic receipts from all sources amounts to some £3,750. The expenses on all accounts amount to £64,838 13s. 4d., and compare with £64,959 17s. 6d., so that practically the expenses are the same. Following the prudent course which the shareholders have repeatedly approved, we have, however, written down certain items and the actual expenses of working the system and maintaining the lines are somewhat lower. The falling off, or as I should perhaps say, the fluctuation of the message business has occurred mainly in the trade with India, and would have been greater but that it has been partially compensated for by increases in other sources of revenue. You will no doubt remember that on a previous occasion I drew your attention to the fact that with Indian business there cannot be the same continuous and always increasing amount of traffic which is expected, and which now almost invariably makes itself manifest with differently constituted countries, such as Australasia. I am pleased to tell you the agreement with Australasia, under which the Government guaranteed a proportion of the loss arising from the introduction of low tariffs, without which guarantee these tariffs could not have been introduced, has been extended, and will now run for a further period of five years. Certain modifications of these arrangements have been effected, but these will not prejudicially affect our receipts. I think I may congratulate the company, therefore, on the establishment of a very considerable period of these low rates. Our business continues to be performed by our own and the Government lines in connection with ours in a manner which appears to be quite satisfactory to the mercantile public. We have no complaints, but many expressions of satisfaction, and those who actually use the wires, and may therefore be supposed to know their own business, and know the best thing, and the large number of letters exchanged with our company, show that the return given by the Government and the company in the costly and efficient working of their lines under circumstances always of great difficulty through pretty nearly all the extremes of climate in the world, is completely satisfactory. In fact, no exertion is wanting on our part to run abreast, and even ahead of the requirements of the mercantile world, and we therefore feel confident we shall maintain and continue the agreeable relations with our customers. Our whole system continues in excellent working order. Our reserve fund also continues in excellent order owing, I think, to the honesty and extreme care with which our investments on that account have, and, I trust, will continue to be made. It may interest you to know at the present moment, if sold, they would realise upwards of £20,000 more than their cost price. There is just one other point which, I think, I ought to touch upon, seeing the very high prices that our shares have reached, and that is the terminability of our concessions, which, as most of you are doubtless aware, run out in the year 1895—perhaps I should rather say, are liable to terminate in the year 1895. In the concession to which I may now more particularly refer, the clause says: "The company is bound to come to terms with the Government before the date on which the concession would otherwise expire, or the lines pass over to the Government." Consequently, although I feel bound under the circumstances publicly to call attention to this point, I must not be understood to do so with any pessimistic view whatever. Anything of that sort is far from my thoughts, but only because I feel there may be some amongst our shareholders who are unacquainted with the details of the concessions. We shall of course, the moment the time has arrived, enter upon the negotiations which, as pointed out in the concession itself, are the necessary and proper course to adopt, and you may depend upon it we shall be mindful of the great interests we have to represent. You know how much the company owes to the efficient services of our managing director, Mr. Andrews, who this year completed his 25 years with us, and also to Mr. Moll and Mr. Pugenkopf, and in fact to all our staff, both at home and abroad. You could not be better served we are well assured. The two directors who retire are Major-General G. B. Tremenheere and myself, and both offer themselves for re-election. I beg to move the resolution.

Major-General G. B. Tremenheere seconded the motion.

A Shareholder asked which Government it was they had to deal with.

The Chairman said that there were three Governments they had to deal with when their concession came to an end—the Persian, the German, and the Russian; but he hoped they would be satisfied with no specific return of which Government it was at that meeting. The concessions did not expire at the same time.

The motion was then carried.

Oriental Telephone and Electric Company, Limited.

The first annual meeting of this company was held on Monday at Cannon Street Hotel.

Mr. William Addison, who presided, remarked that the reconstruction of the company had been accomplished satisfactorily and with as little expense as could have been anticipated. They were now fairly launched on their new career, with all the shares of the same value and without a fraction of liability on any of them. The liquidators of the old company made a distribution last year to the shareholders equal to nearly 4½ per cent. per annum on the amount of the new capital, and for a period of 14½ months, consequently the dividend now to be paid would only be for about 9½ months. He was glad to say that the business generally was progressing, and, although the present capital was more than that of the old company on which dividends were paid, the rate per cent. of the dividend was higher than in any former year. The revenues from the subsidiary companies in India were improving, and should silver rise in value they might expect still better remittances on account of the shares they held in them. Although the rate of exchange had told hardly against the business of the China and Japan Telephone Company, the board hoped, now that the war had been concluded, that the business of the company might be extended. In conclusion, he moved the adoption of the report.

Mr. H. Grewing seconded the motion, which was agreed to.

Mix & Genest, Limited, Berlin.

At the last week's meeting of shareholders of this company, a dividend of 11 per cent., payable forthwith, was declared for the year ending December 31st, 1894. The gross profit amounted to 434,552 marks, which, after deducting expenses amounting to 152,391 marks, leaves an available profit of 282,161 marks. After writing off 48,000 marks on plant and tools account, and 40,000 marks off patent account, which latter stands now nominally at 1s. only; and after transferring 7,000 marks to the workmen's benevolent association, a balance of 630 marks was carried forward to the new account. The board of directors state that the works have been busy since the beginning of the present year with large orders from various governments, as well as from their regular trade customers, and the prospects are very promising, as all their hands, numbering nearly 1,000, are fully employed. The company have concentrated their various works since the beginning of January in their newly erected large factory, the cost of which, including outfit, came to 1,100,000 marks. The building, one of the finest in the telephone trade, is fitted up with the most modern machinery and appliances, and sufficient adjoining land has been acquired for an ultimate extension when necessary.

Submarine Cables Trust.

The annual meeting of the certificate holders was held yesterday. Sir John Pender, who presided, said he wished to make an amendment, which was the re-election of the auditors, and suggested that Messrs. Deloitte, Dever and Griffiths, and Gane and Jackson instead of Mr. Griffiths, and Mr. Gane be elected in the absence of those two men, and might result in inconvenience, but if the heads of the firms, such inconvenience would not arise. He then went through the various items in the accounts. Expenses showed a slight decrease. They recorded with regret the death of Viscount Monck. Revenue had enabled them to meet two coupons of £3 each. There was a balance of £1 5s. in arrear, which they hoped to have cleared off in the summer. The position was satisfactory, notwithstanding the decrease of revenue. The report and accounts were then adopted.

TRAFFIC RECEIPTS

The City and South London Railway Company. The receipts for the week ending April 28th, 1895, amounted to £900; week ending April 29th, 1894, £901; decrease, £1; total receipts for half-year, 1895, £16 119 corresponding period, 1894, £15,514; increase, £605.

The Liverpool Overhead Railway Company. The receipts of this railway for the week ending April 28th, 1895, amounted to £1,121; corresponding week last year, £667.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending April 26th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,178.

THE TELEPHONE SERVICE: PARLIAMENTARY INQUIRY.

The Select Committee of the House of Commons appointed to consider the present working of the telephone system, resumed its sittings after the Easter recess on Friday, Mr. Arnold Morley, Postmaster-General, presiding.

Mr. W. H. Dickinson, deputy-chairman of the London County Council, resumed his evidence, and said the County Council referred the agreement to the Highways Committee. That committee came to the conclusion that the effect would be very materially to strengthen the position of the telephone company, because it contemplated giving them similar facilities to those which the Post Office had. It gave the company the opportunity of using the post offices as call offices, and to send messages by express messengers, and by letter and telegram, to all those places which the committee were aware of. And then, further, they contemplated handing over the power to the company of putting their wires along the public roads where the Post Office had powers, and giving them facilities to connect their exchange by means of subways. In regard to taking the wires along with the Post Office, that was a matter of course between the Post Office and the telephone company, and outside the provisions of the Council's veto. The work in connection with the connection of exchanges would be done by the Post Office at the instigation of the telephone company entirely without any reference to the County Council. A great deal had been said about the veto of the County Council, but nothing could be done under that agreement in regard to exchange wires.

The Chairman: That is confined to exchange wires.

Witness said that was so. As far as they could learn, the effect of the agreement would be to materially increase the charges which would be made for conveying messages along trunk wires, and he would give them a few instances. Towns at distances varying from 20 to 25 miles would, under the agreement, pay 6d. per trunk message instead of 3d. as at present; towns between 40 and 50 miles, 1s. instead of 6d.; towns between 50 and 75 miles, 1s. instead of 9d.; towns between 80 and 100 miles, 1s. 6d. instead of 1s.; and between 100 and 125 miles, 2s. instead of 2s. 6d. For instance, a message sent from London to Eastbourne would, under the old arrangement, pay 9d., but under the new would pay 1s. The general effect would be to increase the charges within a distance of 200 miles. A person telephoning from Coventry to London now paid 1s., but under the new arrangement he would pay 1s. 6d. While the same would be the case from London to Leicester. To Nottingham and Wolverhampton now costs 1s. 6d., and under the agreement it would cost 2s. Over 200 miles the charges were diminished. They also took objection to clause 8 with regard to the terminal charges. The clause said that where messages were sent to another town where there was another company, it was possible for a terminal charge to be made on delivery in the other town. That applied in all cases, except when the National Telephone Company was the company in the town where the message was sent to. The result of that clause, it seemed to them, would be to very much handicap any other company but the National Telephone Company. It seemed to them that that clause would naturally affect the position of any other company or authority carrying on a telephone business in England, and the Council thought it should be objected to.

The Chairman: These are objections to the existing agreement; if you have remedies to apply we should be glad to hear them.

Witness: I think the remedy is that competition should be put on an equal footing.

The Chairman: You are leading up, are you, to some substantial proposition in order to meet these objections?

Witness: I was trying to show what the effect of this agreement will be. The effect in this particular instance is to give a certain pull to the National Telephone Company over any other company which is started, or any other party carrying on telephonic business.

The Chairman: I have no authority to speak as to the position of Parliament on that point, but I think you may assume if licenses are given to other companies the same facilities will be given.

Witness: With that assurance the position is materially changed. If this were not so, it would render competition impossible.

The Chairman: I have no authority to make that statement, but I think you may take it there would be equal treatment meted out to any company.

Witness, continuing, said that as to the telephone system itself, as far as they had been able to gather in London, it was certainly not good. No doubt the system had improved, but still complaints were made very generally about it. They had a letter from the vestry clerk of Battersea with regard to the complaints they had to make. At any rate the telephone service in London was not taken up to anything like the same extent in London as in other parts of the world. In London there was one subscriber to every 540 of the population; in Edinburgh one to 240; in Amsterdam one to 231; in Rotterdam one to 214; in Brussels one to 192; in Paris one to 187; in Rome one to 180; in Vienna one to 177; in Dresden one to 84; in Copenhagen one to 83; in Berlin one to 66; in Christiania one to 36; in Zurich one to 33, and in Stockholm one to 22; so London stood well ahead of all the principal towns in Europe in deficiency of telephonic communication.

The Chairman: Do you think that that is due to the fact that London has a far better telegraphic service than other towns?

Witness said he thought it was due to two facts. One was that the service was not good, and the second was that it was excessively expensive. The charge in London was £20, and £17 10s. for a five years' subscriber. In Paris the charge was £16; in Berlin £7 10s.; in Belgium varying from £5 to £10; Gothenburg £5 11s. 1d.; Stockholm £4 8s. 11d.; Copenhagen £8 6s. 8d.; Dutch towns about £2 17s. 10d.; Switzerland worked out at something like £4 a year. In Manchester there was a competitive company, and the charge was £5 7s.; in Canada it was about £4 a year. These figures led the Council to conclude that the charge in London was unnecessarily expensive. They understood that in American towns it was more excessive; they believed it was £30 in Chicago. In order to ascertain as to how little it could be done at, they obtained reports from several gentlemen. Their own engineer reported that a service could be supplied to 10,000 subscribers in London, at a capital expenditure of something like £400,000, which would necessitate an annual charge of about £90,000 on capital, and would be covered by a charge for the service of £10 a year. Mr. Newland estimated for a similar number of subscribers a capital expenditure of £356,000, requiring an annual charge of £75,898, and that subscription would work out at less than £10. Mr. Bennett estimated the capital expenditure at £76,793, which was about the same as that of Mr. Newland, the subscription working out between £8 and £9 a year. Those three reports were got out quite independent of each other, and corroborated each other in a remarkable way, and showed that 10,000 subscribers could be served with a new system, and a subscription of something under £10 a year would be sufficient.

Sir Julian Goldsmid: Would that be going over houses?—That included everything I believe. Our instructions were that everything should be taken into account.

The Chairman: What area would that cover?—I think that is the county of London.

A much smaller area than the National Telephone Company supplied?—Oh, yes.

Their district is 630 square miles. Your jurisdiction does not extend so far?—No; it is not more than about one-fifth of that. But I may mention that a very small fraction of the work is done outside London.

Does the estimate take into account the royalty to the Post Office?—Yes.

You are aware that a large portion of London is telephoned for £10 a year?—I was only under the impression that was so where the subscriber has offices as well.

Continuing, Witness said the Highways Committee investigated the accounts of the Telephone Company as far as they were able to obtain them, and they came to the conclusion that the reason to a great extent why the charges were so high was the very large capital of the company. On December 31st, 1894, it was £4,493,155, and they noticed that the proportion of the gross revenue rentals of the company was very much changed of late years. The capital of the National Telephone Company in 1889 was £854,000, and at that time the gross rentals were more than 40 per cent. of the capital expenditure. In 1893 the rentals were only 15 per cent. of the capital expenditure. The committee were aware that the National Telephone Company and the United Company were amalgamated in 1889, and the same remark applied to the United Company. In the United Company, in 1887, the rentals were 44 per cent. of the capital expenditure in London. The United Company was formed for London alone, and although they extended from London in later years, their London accounts were kept sufficiently correct to show their receipts. The rentals in London were 44 per cent. to capital expenditure, and now they were only 15 per cent., so the process of the last few years had been so to increase the capital that the gross rentals themselves were a very much smaller percentage to capital, so that they were able to compare the expenditure to a town like Christiania, where there was only a charge of £4 8s. 11d. per annum, and yet their gross rentals amounted to 26 per cent. of the capital. That evidence seemed to them to be very remarkable. London was now in a worse position than if there had been no amalgamation, because if the United Telephone Company had gone on they might have expected some diminution in the charges, because they were in the position of receiving 44 per cent. rentals. The same remark applied to the profits of that company. In 1889, the total profit of the United Company was £94,264. That, on their nominal capital of £900,000, was 14 per cent. If that company had gone on paying 14 per cent., there might have been some chance of a reduction in the charges, but the process which took place was that the £900,000 shares of the United Company were taken over by the National Company for £1,484,000; so that it was now represented as capital of £1,484,000, paying a dividend of 5 per cent. The original shares of the old company were still earning 15 per cent., and the process of amalgamation had been to reduce the interest, reducing the amount of money received by the shareholders, and there was little chance of any reduction taking place in the charges with such an enormous capital.

The Chairman: Assuming these are facts, what do you draw from them? What are you going to propose?

Witness said he would like to give another instance. As far as they could understand, the National Telephone Company had taken over the New Telephone Company, and paid £120,000 for 3,000 £1 founders' shares, and also £74,700 premium on the other shares. All that went to swell the capital of the company and render it impossible, unless something was done, to reduce the charges in London. The only way to reduce the charges seemed to them to place the National Telephone Company face to face again with some kind of competition, either by companies or municipalities.

The Chairman: The effect would be that where competition in the past has brought about these great changes, you think that competition would be the remedy now to reduce the charges.

Witness said it depended on what the company was in 1911, for the Government might take over the company, but not at an exorbitant sum; there was nothing to oblige the Government to take it over, except that the people wanted telephonic communication. That brought him to the position the County Council took, namely, that if the telephone company went on with the agreement, the municipalities should have the authority to carry on a system.

Sir JAMES FERGUSON: Supposing you were to succeed in obtaining municipal licenses. In what way could the municipal exchange be placed in telephonic communication all over the country, unless the sender of the message has to pay something for that great accommodation. Why should the subscriber to the municipal exchange have the benefit of the established system all over the country without having to pay something for it?—My observation was made more to the effect of it.

I only want to get at what you suggest as fair. You say the subscribers communicating with a foreign exchange would be subject to a terminal payment. Do you suggest he should have that privilege without paying for it?—No; I can only suggest it should be left to agreement.

Would it not be the same thing if the holder of a ticket on the Metropolitan Railway expected to be carried to Birmingham?—I quite understand your question. Naturally the other company asks for some kind of payment.

Then can you maintain it as a fair objection that the local subscriber should have to pay?—I do not think I can go beyond what I said. I merely quoted it to show the effect it might have on any competition which might take place.

Mr. SNAPE: In the framing of the estimates you have given us, was the present area contemplated, or the restricted area of the Council?—I think in the county area alone.

And that is not so large as the existing area?—It is not so large as the London area; it is about one-fifth.

Therefore, if you make a lower charge, you would not give the same facilities?—We should have to treat places like Kingston and Epsom, and such places, as if they were outside towns.

Practically, it means you give less facilities and make a lower charge?—Of course we should have to treat other towns as if they were connected with trunk lines, and probably have to charge, but the work done is very small indeed as compared with the work done in the county area.

Have you also taken into consideration the question of way-leave?—Yes; we gave instructions to report on a whole new system.

Is that for overhead or underground wires?—Well, if I remember rightly, a great deal of it was underground.

In that case you would not have to pay way-leaves?—No.

If the result of this inquiry is that the company is left in its present position, would you give them greater powers to make it more efficient?—I think the more powers given the more expensive it will be to buy them out.

Replying to Captain BAGOT, WITNESS said that the question of terminal charges might well be left to agreement, for it would be as broad as it was long.

Sir GRANT LAWSON: What you contemplate is, that the London County Council should have the telephone in London?—My personal opinion is, that it would be advantageous if anything is done to have competition by municipal authorities.

Sir JULIAN GOLDSMID: You have been good enough to tell us sometimes that you represent the Council and sometimes yourself. Do you represent yourself when you say you want to have control of the telephone?—I have said nothing in chief but what I think the Council will agree to.

Do you represent yourself or the Council in saying you are in favour of asking the Post Office to grant municipal licenses?—The Council has not come to that conclusion.

Then you do not represent the Council: There is nothing I have said inconsistent with the position of the Council on that point.

Now, Mr. Dickinson, you are a man of ability, and can comprehend the question. Then you do not represent the Council?—The County Council has not expressed its opinion with regard to establishing a telephone.

When you talk of putting municipal competition into the hands of the London County Council, may I ask you if the Council is the road authority for London?—No, it is not.

Therefore they would have to go to the road authorities to take up the roads, as well as to private houses to go over houses?—If the Council took the system over, they would have to get further powers.

Therefore they would get greater powers than the telephone company has?—I think Parliament would give it greater powers.

Then you would have to apply to Parliament for greater powers than the telephone company possess?—Yes.

If the Government granted you and other municipalites licenses, would it not be obvious there would be a greater difficulty in negotiating matters if the Government took it over, if they had 20 or 30 licenses instead of one?—Yes; but I think they would get it cheaper.

But you would agree that it is more serious to deal with 20 companies rather than one?—It is not my view.

If you were satisfied that the cost would be a great deal more to extend over a much larger area—five times as large—because the London area you said was about a fifth of the total area supplied by the National Telephone Company, would you think it reasonable that some difference of charge should be made between the county area and the larger area?—I say the work in the London area is not much out of the county area.

You go into another point. If you supply an area of 50 miles, it might be reasonable to charge one price; but if you supply a radius of 350 miles, it might be reasonable to charge another price. Is not that the difference between the municipal area and the area supplied by the National Telephone Company?—If you mean that is the reason why the charges are higher, I say that is not the case.

I merely ask whether it is not reasonable whether there should not be more or less a proportionate charge in accordance with the area which is supplied? Is it not true, also, that there is no area which can be compared to London?—We understand that the radius of Stockholm is 2 miles.

It is a radius of one square mile. When you talk about your municipal licenses, do you propose to include the City?—I do not think I made any proposal about a municipal license. I am not authorised.

Sir JULIAN GOLDSMID: Then we have got to that. You are not authorised. Thank you very much.

Examined by Sir CHARLES CAMERON, WITNESS said the telephone service in London had grown up by chance, and was not skilfully laid out to the best advantage. Supposing the municipality, or a new company, carefully designed and laid out a telephonic service, the Government would make a cheaper bargain in taking it over. If the Government did not take it over, he thought competition was the best way to develop the system, and that was the reason the Council sent him there. He was in favour of its being a Government monopoly, but the Council had not settled that. He would prefer immediate competition.

Replying to Mr. ELLIS, WITNESS said the Highways Committee had not received any evidence of the inefficiency of the system. He could lay no specific complaint before them but that of the vestry clerk of Battersea, and at the end of that complaint there was a statement that the wires were now working satisfactorily.

By Sir FRANK LOCKWOOD: He was perfectly justified in saying that the terms of the resolution passed by the Council, namely, "restriction," "taking over by the State," and "placing the telephones in the hands of the telephones," were in the minds of the Council in the discussion which took place on March 25th, and which led to the division. He thought if licenses were granted to municipalities, they should be granted for a term of years.

The CHAIRMAN: Did the estimate you mentioned take into account the necessity of a sinking fund within 17 years?—It took into account a sinking fund at 25 years. The difference between 17 and 25 years would not be very material.

Sir EDWARD H. CARBUTT, Bart., M.I.C.E., said he was chairman of the Engineering and Allied Trades' Section of the London Chamber of Commerce, and he came there to support six resolutions passed by the Chamber on the recommendation of the special committee appointed on the telephone service. The resolutions were as follows:—(1) Acquisition of Telephones by the Government. "That this Chamber, whilst favouring private enterprise, is of opinion that if greater development of the telephone service which the commercial community demands can be better secured by the State acquiring and working the whole system of telephones, then this Chamber would approve the adoption of such a course." (2) Validity of Telephone Agreement. "That the late Chancellor of the Exchequer and the present Chancellor of the Exchequer having in their places in Parliament stated that the agreement between Her Majesty's Post Office and the National Telephone Company was a binding agreement, it would be useless and a waste of time on the part of this committee re-opening the question at present." (3) Competing Systems. "That properly controlled competition should be encouraged providing that intercommunication between different systems covering the same area can be satisfactorily arranged, and subject to the Post Office authorities deciding, after due and adequate inquiry, that the public can be better and more economically served than by the existing arrangements." (4) Standard Regulations. "That in the opinion of this Chamber it is desirable that standard regulations should be drawn up by a Government department for the guidance of local authorities in determining the conditions to be imposed by them as a preliminary to their consent being given to telephone companies obtaining statutory powers." (5) Varying Rates for Limited Services. "That the desirability of developing the principle of varying rates for limited services should be emphasised by the evidence before the Select Committee." (6) Unprofitable Areas. "That in granting licenses, precautions should be taken to avoid the neglect of telephone service in relatively unprofitable areas." The special committee consisted besides himself of the following gentlemen:—Mr. Emile Garcke (chairman of the Electrical and Allied Trades Section of the Chamber and managing director of Electrical and General Investment Trust), Major S. Flood Page (director of the Edison and Swan United Electrical Light Company), Major-General C. E. Webber (Chelsea Electric Light Company, and past president of the Institution of Electrical Engineers), Mr. A. R. Bennett (New Telephone Company), Mr. J. Chambers, Mr. H. Clark (Mander Brothers), Mr. R. E. Crompton (president of the Institution of Electrical Engineers), Mr. W. E. L. Gaine (general manager of the National Telephone Company), and Mr. D. Howard (Messrs. Howard & Son). They believed that if the Telephone Company could make the charge lower it would be a great deal more used. With regard to varying rates of limited areas the charge to a rich man did not amount to anything, but there were a large number of cases they considered if people could get connection with shopkeepers they could afford to pay a small charge for the use of the telephone. What they wanted was that the system should be within reach of the poor as well as the rich. He believed that in agricultural districts it might be a great help to agriculturists, and it might be done in the same way as it was proposed to deal with light railways. The only way to make trade go on was to give all facilities possible.

Replying to Sir James Ferguson, WITNESS said the opinion had been expressed that if the Government could buy London at a fair and reasonable price it would be best. They thought London should be dealt with on a different basis from the country.

The CHAIRMAN: And leave the rest to the National Telephone Company?—Yes, if arrangements could be made.

Replying to various members of the committee, the WITNESS said that if competition was decided on, standard regulations should be drawn up which should be applicable to all towns. What was meant by unprofitable areas was if a company applied for a license for a district and it was granted, that company should not be allowed to pick and choose which part of the district it should supply, but should supply the whole district. The Chamber would leave it to private enterprise rather than the parish, or district, or County Council should supply the service. Personally he would object to a local authority

supplying the service out of the rates. Their main resolution was No. 3, but he did not think it a very limited approval of competition. The varying rates had been in operation in Kensington. He would object to any body taking the interior area of London and leaving the outside to some one else. He would express no opinion as to whether municipalities should be given licenses.

Major S. Flood Page, of the Chamber of Commerce, said he also came to support the resolutions which had been given in by the previous witness. He would point out that the first resolution governed the whole of the others if acted upon, and with the exception of the second, the other resolutions were alternative to the first. The resolutions were the result of a great deal of discussion, but there was little difference of opinion on the fourth. Comparing the telephone with electric lighting and electric traction, it had made by far the greatest progress, and they thought that in the next ten years it would increase enormously. With regard to the third resolution, their position was that, before competition was approved, there should be adequate inquiry, and their justification of competition was, that the services could be better and more economically done. If they could not be better and more economically done, then they would not be in favour of competition. If there was to be competition, it was very important that there should be standard regulations drawn up by the Government Department for the guidance of local authorities. They did not suggest that arbitrary resolutions should be imposed on the National Telephone Company. The National Telephone Company were already extending the system of varying rates. He thought that there should be no obligation on anyone obtaining a license to carry out the work; that had not been done in the case of electric lighting.

Mr. H. Montague Bates, Chief Clerk to the Commissioners of Sewers, said he had had 11 years' experience in the working of telephones in the case of the exchange and three private wires. His experience was, that the service was very inadequate. In the first place, when they wanted to get into communication there was often a delay, and after waiting patiently for some time, they were told that the line was engaged, and they must ring up again. His opinion was, that the obligation to ring up again should rest upon the exchange. Much inconvenience was also caused by being rung up by mistake, and in being put on to people one did not wish to speak to. He had complained, but he felt it was not entirely the fault of the people at the exchange, but that the system was wrong, and the defects were caused by reasons over which the exchange people had no control. An application had been made to the Commissioners of Sewers to become subscribers to a system for supplying the service at a maximum price of £8 per annum, and they agreed to allow a telephone tube to be issued, which was laid by the City of London Electric Company without the knowledge of the Commissioners. The applicant was Mr. H. S. Foster, M.P. They were negotiating with the City of London Electric Lighting Company, and nothing more had been heard of that proposal. The Commissioners had expressed no opinion as to competition. There were a certain number of tubes at present laid in the City which could not be used without their consent. The City of London Electric Company laid them unknown to the Commissioners, and entered into an agreement to lease them to the National Telephone Company if they got the Commissioners' consent. The position of the Commissioners was the desire to see the telephone extended cheaply and efficiently.

The Committee then adjourned till Tuesday.

TESTS OF GLOW LAMPS, AND DESCRIPTION OF THE MEASURING INSTRUMENTS EMPLOYED.*

By Prof. W. E. AYRTON, F.R.S., and E. A. MEDLEY.

The conditions under which the glow lamp can be most economically used have attracted considerable attention since a paper entitled "The most Economical Potential Difference to Employ with Incandescent Lamps," was read before the Physical Society in February, 1885, by Prof. Perry and one of the authors of the present communication. In this paper they stated that it was well known, from experiments made by their students in 1880, and from results published in 1881 by Lord Kelvin, then Sir William Thomson, as well as from subsequent experiments, that the light obtained from an incandescent lamp increased much more rapidly than the power expended in it, or that the number of candles produced per watt of power expended in the lamp increased as the filament became hotter. But it was pointed out in the paper in question that such experiments by themselves gave no idea of the commercial value of any particular glow lamp, because they afforded no indication of its life when run at different efficiencies, and it was known that the length of time a filament would last was the less the higher its temperature.

They then proceeded to show that the cost of lighting per hour per candle could be divided into two parts, viz., the cost as to lamp renewals and the cost as to power, the first being equal to the price of a lamp divided by the product of its life into its candle-power, and the second to the price of one watt-hour multiplied by the watts per candle. So that, if $L(v)$, $C(v)$ and $W(v)$ were the life in hours, the candle-power and the watts per candle respectively expressed as functions of the pressure in volts kept constantly on the lamp, and if p were the price of a lamp, and H the price of one watt-hour, then the cost per hour per candle equalled

$$\frac{p}{L(v) \times C(v)} + H \times W(v),$$

and the value of v, which made this expression a minimum, they showed was the proper P.D. to employ with the particular type of lamp.

The authors gave two methods of solving this problem defined by their equation of cost—the one a graphical method, and the other an analytical one. The graphical method consisted in drawing curves from the best experimental results then available to represent $L(v)$, $C(v)$ and $W(v)$ respectively in terms of v, and from these three curves finding the values of $L(v)$, $C(v)$ and $W(v)$ for many values of v, then, by substitution in the cost equation, data were obtained from which a last curve showing the relation between potential difference and cost per hour per candle could be drawn.

The curves on p. 45 *Proceedings* Physical Society, Vol. vii., 1885, showed the results obtained when this method was applied to the case of 16 C.P. 100-volt Edison lamps, using as experimental data the results of tests, made at the Finsbury Technical College, on the relations between candles, volts and watts, and the values of the life of this type of lamp when run at different pressures, as published by M. Foussat.

The curve, A A A, showed the cost per candle for lamp renewals during 560 hours when the price of a new lamp was 5s.; B B B, the cost per candle for power during the same period, 1 horse-power for 560 hours being reckoned at £5, and C C C gave the total cost per candle for 560 hours. The ordinate of this latter curve had a minimum at about 101·4 volts.

With the analytical method, on the other hand, empirical equations were first found to represent as nearly as possible the experimental results. Thus it was found that

$$\frac{1}{L(v) + C(v)} = 10^{0{\cdot}07545\, v - 11{\cdot}097}$$

and

$$W(v) = 3{\cdot}7 + 10^{0{\cdot}097 - 0{\cdot}07067\, v};$$

therefore, the total cost per hour per candle equalled

$$p\, 10^{0{\cdot}07545\, v - 11{\cdot}097} + H\,(3{\cdot}7 + 10^{0{\cdot}097 - 0{\cdot}07067\, v}).$$

From this equation, using the same values for the price of lamps and power as before, it was shown that to make the cost a minimum the P.D. maintained between the lamp terminals should be 101·1; a result in close agreement with that obtained graphically.

At the next meeting of the Physical Society a paper was read by Dr. Fleming, in which he considered what proportion the cost of lamp renewals should bear to the cost of power in order that the total cost should be a minimum. As the result of the examination of various experiments, he showed that for any particular type of lamp the average life could be expressed as an exponential function of either the watts per candle, or of the candle-power, or of the P.D.; that is, he showed, for the lamps with which he was dealing, that

$$L = \frac{A}{W^{\alpha}} = \frac{B}{C^{\beta}} = \frac{1}{v^{\gamma}},$$

where L was the life, W the watts per candle, C the candle-power, v the P.D., and A, B, α, β, and γ constants for any particular type of lamp. Then, by substitution in the cost equation already referred to, he obtained the result that for maximum economy the cost of power must be to the cost of renewals as $\alpha \frac{\beta - 1}{\beta}$ to unity. The values for α and β he gave for Edison lamps as 6¼ and 4½ respectively; so that he finally arrived at the result that, whatever the price of lamps, or of electrical energy, the pressure used must be such that the annual cost of renewals should be about 17 per cent. of the total annual cost.

In April, 1888, in a paper read before the American Institute of Electrical Engineers, Mr. Howell gave numerous examples of the application of Ayrton and Perry's graphical method to the finding of the efficiency at which various types of lamps should be run to obtain maximum economy for various prices of lamps and power.

He gave a curve showing the results of his tests of Edison lamps when run at different efficiencies, but the lamps he used were so abnormally good, compared with any with which we are acquainted, that his experiments have no practical value. For example, his lamps run at 4·5 watts, a candle lasted, he says, nearly 12,000 hours.

Further, Mr. Howell's paper can hardly be said to have advanced the matter beyond the point at which it was left by the considerations contained in the paper on "The Most Economical Potential Difference, &c.," read before this Society in 1885; for he took no account of the changes which more recent experiments had shown to occur in lamps during their life, and which render any results obtained by methods that disregard these changes useless for practical purposes.

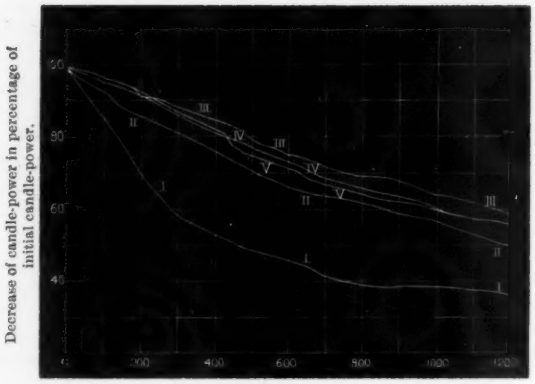
Numerous experimenters had found out that there was a serious diminution in the light emitted by a lamp as it grew old, and also a very considerable rise in the watts consumed per candle. Further, there was evidence to show that the shape of the curve between candle-power and time is not the same for different pressures; so that it had come to be recognised that, in order to determine the P.D. at which lamps should be run, it was useless to make a comparison merely between the efficiency of lamps when new and the number of hours they will last at various voltages.

Moreover, this falling off in the quality of a lamp as it ages led people to consider another point, viz., Might it not be possible, in consequence of this deterioration, for a lamp to be economically dead before the filament had actually broken? For the increased cost of the current required, compared with the light given out, might more than overbalance the expense of replacing the lamp with a new, and, therefore, more brilliant one.

* Paper read before the Physical Society, January 11th and 25th, 1895.

Before describing the results which we have obtained regarding this interesting question of the existence of a point, called by the Americans the "smashing point," beyond which a lamp cannot be economically used, it will be well to shortly indicate the general conclusions to which previous experimenters have been led from tests on the modern glow lamp.

In November, 1892, Mr. Feldman published a table compiled from the results of tests made by Prof. Thomas and Messrs. Martin and Hassler in America, by M. Haubtmann in France, and from some of his own measurements, which contained mean values for more than 500 lamps taken from 28 different factories, and representing 49 different types. He divided the lamps into five groups according to their initial efficiencies, and gave for each group the average candle-power in per cent. of the initial candle-power and the average watts per candle at every 100 hours in the lives of the lamps. The curves in figs. 1 and 2 are drawn from the figures given in this table, fig. 1



Curves marked.	Initial watts per candle.	Curves marked	Initial watts per candle.
I.	From 2·0 to 2·5.	IV.	From 3·5 to 4·0.
II.	From 2·5 to 3·0.	V.	Over 4.
III.	From 3·0 to 3·5.		

Fig 1.—Tests of American and European Lamps.

howing the candle-power and fig. 2 the watts per candle as the lamps grow old. The numbers I., II., III., IV., and V. on the curves refer to the initial efficiencies of the lamps whose behaviour the curves illustrate, and, as seen from the table on fig. 1, the curves

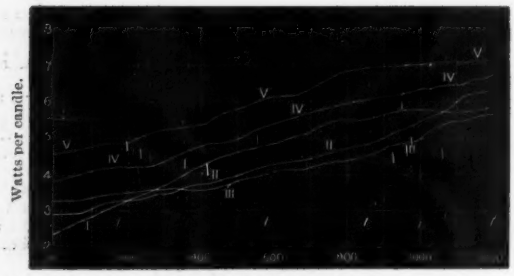


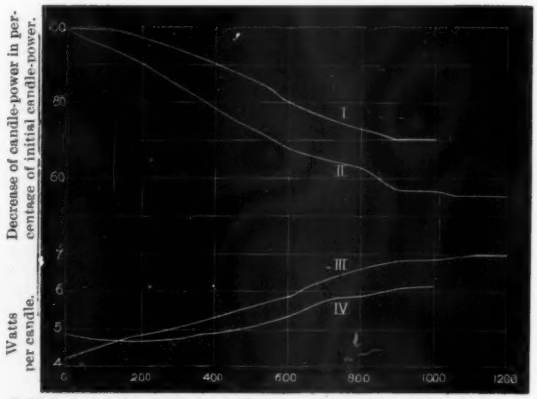
Fig. 2.

marked I. are drawn from results obtained from lamps which initially required from 2 to 2·5 watts per candle; for curves marked II. the initial consumption was 2·5 to 3 watts per candle; for curves III. from 3 to 3·5; for curves IV. from 3·5 to 4; and for curves V. above 4 watts per candle.

These curves show that the fall in candle-power varied from 40 to 65 per cent. in 1,200 hours, or, rejecting lamps having as low an initial consumption as from 2 to 2·5 watts per candle, Mr. Feldman's curves would lead us to expect that the candle-power of an average lamp would fall about 40 per cent. in 1,000 hours.

From the curves marked A in fig. 3, which gives the results of Professor Thomas's tests made in 1892 on 127 lamps of 13 American makes, it can be seen that the average American lamp of that date dropped about 43 per cent. in candle-power in 1,000 hours, the watts per candle in the same time rising from 4·2 to 6·9. The curves marked M on the same figure show the results obtained from the best make of lamp tested by Professor Thomas; the average of the 10 lamps tested showed a drop of 30 per cent. in candle-power in 1,000 hours, and a rise from 4·8 to 6·1 in watts per candle.

In September, 1892, M. Haubtmann published tests on many European makes of lamps. The curves in fig. 4 show the results he obtained from testing twenty 16-C.P. Edison-Swan lamps, ten at 102 and ten at 110 volts. Those run at 102 volts showed a drop of about 30 per cent. in candle-power in 1,000 hours, the watts per candle rising in the same time from 3·27 to 4·4; the lamps run at 110 volts in 1,000 hours dropped 28 per cent. in candle-power, and rose from 3·35 to 4·58 watts per candle.

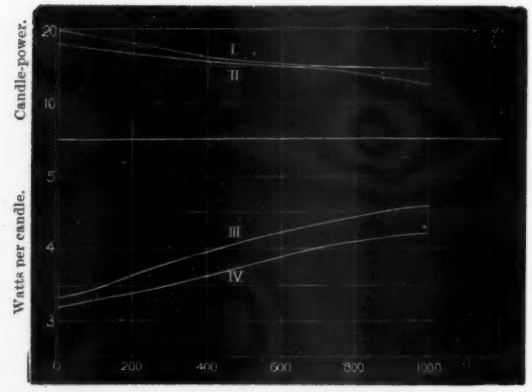


I. M. Best make tested by Prof. Thomas.
II. Average of 13 American makes.
III. Average of 13 American makes.
IV. M. Best make tested.

Fig. 3.—Prof. Thomas's American Tests.

If, now, in the light of the knowledge obtained from these experiments, we look at the equation of cost quoted in the beginning of this paper, we see that some changes must be made in it before it expresses the truth. As originally given it was cost per hour per candle equals

$$\frac{p}{L(v) \times C(v)} + H \times W(v);$$



I. Average candle-power of 10 Edison-Swan 16-C.P. lamps tested at 110 volts.
II. Average candle-power of 10 Edison-Swan 16-C.P. lamps tested at 102 volts.
III. Watts per candle of 10 Edison-Swan 16-C.P. lamps tested at 110 volts.
IV. Watts per candle of 10 Edison-Swan 16 C.P. lamps tested at 102 volts.

Fig. 4.—Tests by M. Haubtmann on 20 Similar 16 Candle-Power Edison-Swan Lamps, 10 of which were Run at 110 Volts and 10 at 102 Volts.

but, as neither the candle-power nor the watts per candle remain constant throughout the life of the lamp, $L(v) \times C(v)$ does not give the total candle-hours obtained during the lamp's life, and neither does $H \times W(v)$ give the true cost of power per hour per candle. The equation must, therefore, be written:—Cost per hour per candle equals

$$\frac{p}{\text{total candle-hours}} + H \times \textit{average} \text{ watts per candle.}$$

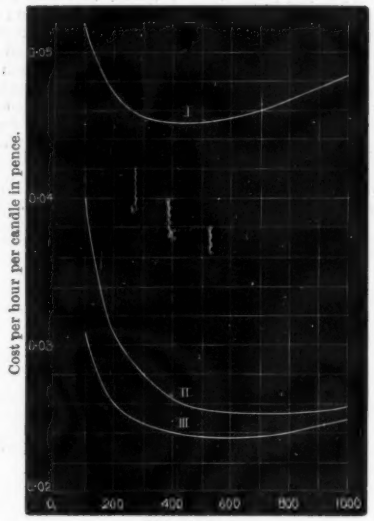
Exactly what these changes in the equation mean will be best shown by working out the results for a particular type of lamp, and for this purpose we have chosen the American make tested by Professor Thomas, the life curves of which are shown marked M in fig. 3.

It is clear, from these curves, that knowing the initial candle-power, in this case about 12·5, we can calculate at any time during the life of a lamp the total candle-hours obtained and the average watts consumed per candle during that time, and by substituting these quantities in the equation of cost we can find the cost per hour per candle averaged over the number of hours considered.

The curves in fig. 5 show the results we have obtained when these calculations are made at different times in the life of a lamp, and for different prices of lamps, and of power. In calculating the figures from which the bottom curve is plotted, we have taken the cost of a new lamp as 1s., and the price of a Board of Trade unit as 4½d., and, as seen, the ordinate of this curve reaches a minimum at about 600

hours, when the cost per hour per candle has dropped to 0·0235 pence. Beyond this point the curve begins to ascend; that is, when a new lamp costs one shilling, and a kilowatt-hour 4½d., and lamps whose life histories are truly represented by the curves, M, in fig. 3, are employed, the cost of obtaining light is least if the lamps are used for 600 hours only, because after that time their diminished quality more than overbalances the cost of renewing.

A change in the price of lamps does not much affect the economical life, as is shown on fig. 5 by the middle curve, which we have calculated for the same price of power, but on the assumption that a new lamp costs 2s. The ordinate of this curve has a minimum value at 650 hours, instead of at 600 hours, when a new lamp was supposed to cost 1s. only.



I. Kilowatt-hour at 9d. Lamps at 1s. each.
II. Kilowatt-hour at 4½d. Lamps at 2s. each.
III. Kilowatt-hour at 4½d. Lamps at 1s. each.

Fig. 5.—Cost Curves Calculated for American make M in Fig. 3.

The higher the price paid for energy, the more important does this question of economical life become, and the sooner is it necessary to discard lamps, because the cost of renewals bears a less proportion to the total cost. This is illustrated in fig. 5 by the top curve, to obtain which we have assumed that the cost of energy was 9d. a unit, and the price of a new lamp 1s. Now the minimum point falls to 430 hours, instead of being at 600, at which it stood when the price of the Board of Trade unit was taken as 4½d.

When cost curves, like those in fig. 5, are drawn for a worse type of lamp, the minimum point becomes more sharply defined and is reached earlier. It might be urged, however, that all such curves merely indicate for how many hours lamps should be used in order that the price paid for the light may be a minimum, but that if at the end of that time the light given out by the lamps is sufficient for the purpose for which they are intended, surely it would be folly to discard them. The answer to this is, that the lamps employed were of too high candle-power for the necessary illumination, and what should be done is to throw away the nominally higher candle-power lamps that have deteriorated, and replace them with new *lower* candle-power lamps.

When, therefore, the special investigation which forms the subject of this paper was commenced at the end of 1892, there was good reason for expecting, first, that with any type of glow lamp a certain number of hours could be experimentally determined, at the end of which it would be economical to discard lamps even when the price of a Board of Trade unit was as low as 4½d.; secondly, that it was only economical to run lamps at the pressure marked on them for one particular price of electric energy.

As Edison-Swan lamps were the only lamps that could be legally used in this country in 1892, and as a pressure of 100 volts was one very commonly employed for electric lighting, we decided to experimentally find out what was the most economical pressure to maintain between the terminals of nominal 100-volt 8-candle lamps of this make, and what was the length of their economic lives for different prices of a Board of Trade unit.

As it is well known that the lives of filaments are considerably affected by the steadiness of the pressure between their terminals, it was decided to run the lamps from a battery of storage cells, and to arrange that the pressure when on the lamps should not vary by as much as one-tenth per cent. The capacity, however, of the cells at the Central Technical College, which could be entirely set on one side for this investigation, and used for running 100-volt lamps from five o'clock every evening to nine or ten o'clock the next morning for five nights of the week, only allowed of nine 8 C.P. lamps being dealt with at a time. The nine lamps were divided into three groups, each containing three lamps, and a perfectly constant but different P.D. was maintained between the terminals of the lamps in each group.

When our experiments were begun it was known that the price of lamps would fall in the autumn of 1893, therefore it was considered hardly probable that any economy would be gained by running the lamps at less than their normal pressure. Hence we decided to run the three groups at 100, 102, and 104 volts respectively. The tests, however, soon proved that no economy could be gained by running these lamps at as high a pressure as that of 104 volts, and so the group running at that pressure was changed for one running at 101 volts.

The pressure of the storage cells which supplied the lamps with current diminished, of course, during the night, so that it was necessary to introduce between the cells and the lamps a variable resistance which could be altered to keep the pressure on the lamps constant within $\frac{1}{10}$th per cent., and to avoid constant attention, it was also necessary that this resistance should be automatically controlled.

As no automatic regulator could be purchased which would keep the pressure throughout the night within $\frac{1}{10}$th per cent. of the desired value, it was necessary to construct such an instrument.

The apparatus which we employed for this purpose resembled generally the one described in a paper on "The Working Efficiency of Secondary Cells," by Messrs. C. G. Lamb, E. W. Smith, M. W. Woods, and one of the authors of the present communication (see *Journal* Inst. Elec. Eng., Vol. xix., 1890).

A variable resistance, consisting of four platinoid wires winding on and off a brass roller, was placed in the main circuit between the cells and the lamps. This resistance was geared to a permanent magnet Gramme motor, the electrical connections of which are shown in fig. 6.

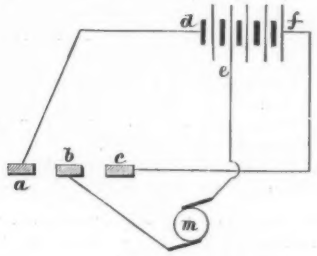


Fig. 6.

d, e, f, was a battery of five storage cells, to the centre, e, of which one brush of the motor, m, was connected, the other brush being joined to the middle cup, b, of a three-way mercury switch, a, b, c. The two outer cups, a and c, of this switch were connected with the two ends, d and f, of the battery.

It is clear from the figure that the motor revolved one way or the other, according as a and b or b and c were connected.

A "set up" D'Arsonval galvanometer, in series with a resistance, was placed across the two points in the main circuit between which it was desired that the pressure should remain constant. To the coil of this galvanometer was attached a pointer ending in a platinum tip which worked between two platinum contacts. The phosphor bronze strip by which the coil of the D'Arsonval was suspended was twisted several times, so shat when the pressure on the lamps was correct, the tip of the pointer rested midway between the contacts. If, however, the pressure rose by $\frac{1}{10}$th of a volt, the pointer was deflected and made to touch one of the contacts, and so to complete the circuit of an electro-magnet; this, by closing one side of the mercury switch (fig. 6), started the motor, which increased the resistance in the main circuit until the pressure was correct again.

Exactly the opposite happened if the pressure fell, the pointer touched the other contact, the other side of the mercury switch was closed, and the motor working in the reverse direction reduced the resistance between the cells and the lamps.

The pointer was kept from sticking to its contacts by a light wooden hammer, which tapped the case of the galvanometer when the motor revolved.

By means of this apparatus it was possible to keep the pressure constant to within at least $\frac{1}{10}$th per cent.

For many nights the action of this regulator was watched pending the arrival of a recording voltmeter; but the recording voltmeter not being forthcoming, and staying up all night, even for four times a week, interfering much with our work during the day, we decided to construct an automatic check on the automatic regulator.

In series with the first galvanometer was placed a second working in exactly the same way, but with its contacts so far apart, that its pointer only touched them for a rise or fall of half a volt in the pressure on the lamps. When for any reason such an alteration took place, the pointer of this second galvanometer, by touching one of its contacts, completed the circuit of an electro-magnet; this attracted a piece of soft iron, which opened a mercury switch, and put out the lamps, and at the same time, by stopping a clock, indicated the time at which the irregularity took place.

Besides acting as a check on the regulating apparatus, this automatic cut-out worked whenever the pressure rose on a lamp breaking, and so made it possible to tell the exact life of the broken filament.

(To be continued.)

NEW PATENTS—1895.

7,584. "Improvements in methods of electric distribution." J. H. Rider and J. Pilling. Dated April 16th.

7,600. "Improvements in and relating to primary batteries." W Rowbotham, H. Levetus, and S. I. Levetus. Dated April 16th.

7,625. "Improvements in electric wire insulators." D. M. Rothenberger, C. A. Inglis, and E. D. Reilly. Dated April 16th. (*Complete.*)

7,649. "Improvements in and relating to electric arc-lamps." E. H. Crosby and O. M. Shaw. Dated April 16th. (*Complete.*)

7,657. "Improvements in secondary or storage batteries." W. M. McDougall, H. B. Adams, and G. P. Smith. Dated April 16th. (*Complete.*)

7,668. "Improvements in systems of electric distribution." J. Devonshire. (Communicated by E. W. Rice, United States.) Dated April 16th. (*Complete.*)

7,703. "An improved electric bell switch and burglar alarm." G. F. L. Alexander. Dated April 17th.

7,705. "Improvements in the construction of holders for electric glow lamps." W. McKenzie and J. A. Fleming. Dated April 17th.

7,711. "Improved method and means of heating metals and ores for forging, melting, smelting, welding, and other purposes, by means of a voltaic arc sprung between the metals or ores and an electrolytic solution." G. D. Burton. Dated April 17th. (*Complete.*)

7,712. "Electric bath metal-heating apparatus for metals and ores." G. D. Burton. Dated April 17th. (*Complete.*)

7,713. "Electric bath metal-heating apparatus." G. D. Burton. Dated April 17th. (*Complete.*)

7,735. "An improved electromotor." H. H. Lake. (Communicated by A. D. Casa, Italy.) Dated April 17th.

7,773. "Improvements in or connected with the production of electricity." H. Tee. Dated April 18th.

7,782. "Improvements in electric resistances." J. F. H. Voigt and J. A. Haeffner. Dated April 18th.

7,785. "Improvements in connection with ventilating electric culverts, test-boxes, and other street boxes." T. Harden. Dated April 18th.

7,788. "Improvements relating to electric arc lamps." W. R. Ridings, G. F. Bull, and L. B. Codd. Dated April 18th.

7,795. "Improved construction of electrical accumulators." V. G. de S. de Dormael. Dated April 18th. (*Complete.*)

7,829. "Improvements in the method of and means for charging electric storage cells." W. J. S. Barber-Starkey. Dated April 19th.

7,837. "An improved apparatus for electrically heating liquids." P. Stotz and F. W. Schindler-Jenny. Dated April 19th.

7,888. "Improvements in electric cells or batteries." E. Eteve. Dated April 19th.

7,910. "Improvements in and connected with apparatus for lighting up roundabouts and the like by electricity." F. J. Borland. Dated April 20th.

7,930. "Improvements in laying electric conductors underground." J. A. Jeckell. Dated April 20th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1894.

191. "Improvements in dynamos." N. S. Keith. Dated January 3rd. Relates to a method of constructing the frames and field magnets of dynamos. 4 claims.

192. "Improvements in electric drills or reciprocating motors, and in dynamos for working the same." N. S. Keith. Dated January 3rd. Relates to drills or reciprocating motors which are caused to reciprocate by two solenoids through which electric current is alternately passed. 5 claims.

3,101. "Improvements in dynamo electric machines." W. B. Sayers, H. A. Mavor, W. A. Coulson, and S. Mavor. Dated February 13th. Has reference to improvements in armatures for dynamo electric machines of the type in which the armature winding is embedded in an iron core, and it has for its object to lessen the self-induction of the armature sections during the period of commutation of the said sections, whilst at the same time allowing of the armature being run with a short interpolar space between it and the polar surfaces of field magnets of solid construction, without causing sensible heating of the said field magnets by Foucault currents. 2 claims.

3,221. "Improvements in electric arc lamps." A. W. Money and H. Nash. Dated February 15th. Has for its object improvements in electric arc lamps, whereby two pairs of electrodes are employed regulated by a single regulating apparatus for the upper carbons, thereby obtaining two arcs in one lamp at only a small extra expenditure of power for their regulation as compared with that now required for the regulation of a single arc. 3 claims.

3,476. "Improvements in and connected with electric bells." H. B. Little. Dated February 17th. Claims:—1. In electric bell mechanism the use of an electro-magnet having a pole piece at each end, the acting surfaces of which are in a plane more or less parallel to the axis of the electro-magnet, substantially as described. 2. In electric bell mechanism, mounting the armature of the electro-magnet on a U-shaped strip or spring, substantially as described. 3. In an electric bell set the of a bobbin or roller for winding on the conducting wires, such bobbin or roller being provided with means for maintaining electric connection between the said conducting wires and the battery and the electro-magnet of the bell mechanism, substantially as described.

3,667. "Improvements in telegraphic apparatus." The Phonopore Company, Ltd. and E. W. Smith. Dated February 20th. Claims:—1. The combination of an induction coil having two vibrators, the secondary circuit of the coil containing a condenser or being doubly wound with a telephone receiver as receiving instrument and a drop handle key or double tapper key with the necessary contacts, substantially as and for the purpose set forth. 2. In combination with apparatus such as is referred to a relay governing a local circuit in which the telephone receiver is placed substantially as described.

3,863. "An improved electric arc lamp." A. E. Jones. Dated February 22nd. The upper carbon holder traverses upon a screw by means of a nut. The nut can be disengaged from the screw for the purpose of raising the upper carbon holder to renew the carbons. The screw rotates in a bearing, which bearing is raised by a bell crank lever attached to the armature of an electro-magnet whose coils are in the main circuit, the arrangement described serving to strike the arc. The upper carbon is caused to approach the lower carbon, as the carbons are consumed by the rotation of the screw. The said screw is rotated by the action of a pawl on a ratchet wheel, the said pawl being at one extremity of a lever carrying an armature acted upon by an electro-magnet, whose coils are in the shunt circuit, that is in parallel with the arc. 1 claim.

4,113. "Improvements in electric batteries." H. T. Barnett. Dated February 27th. Consists in employing air as a depolariser, and that the negative electrode may readily obtain the oxygen therefrom, the inventor forms it partly or wholly of a substance possessed of a considerable combining or occluding affinity for oxygen, and a conductor of electricity of porous texture, and causes the same to be practically situated wholly in the air, but with some considerable portion of its surface in contact with the solution surrounding the positive electrode. 4 claims.

4,190. "Improvements in apparatus for use with electrically illuminated signs or advertisements, or in other cases where frequent changes of electric circuits are to be made." E. L. Berry and F. Harrison. Dated February 27th. The inventors provide the circuits which are to be made and broken alternately with a switch so constructed and operated, that the contact for the one circuit is made before the contact for the other circuit is broken, and we interpose a resistance in the circuit. 3 claims.

4,691. "Improvements in apparatus for connecting and disconnecting electrical circuits." A. P. L. G. C. Lundberg and G. Pegg. Dated March 6th. Have for their object the production of a switch for controlling electrical circuits, which may be turned either to the right or left, for "on" and "off" position; or all round in either direction, "on" and "off" positions being obtained by alternate quarter of a circle movements; and at the same time the additional advantage of a spring-actuated independent "make" and "break" (which is assisted in its action by the contact springs or spring-controlled contact plates used in the switch, when the "dead point" is passed) when, passing from "off" to "on" or "on" to "off" respectively. 3 claims.

5,340. "Improvements in the construction of electrical resistance coils." J. A. Fleming. Dated March 14th. Relates to methods of making and winding coils of metallic wires on frames or supports so constructed that when an electric current is sent through the wire or wires, thereby heating it or them, the wire is always preserved in the same state of tension, and the expansion of the wire due to heat is compensated by an automatic adjustment of the dimensions of the frame, or frames, on which the wire is wound. 2 claims.

7,121. "Improvements in electric lighting apparatus for railway cars and the like." W. Biddle and P. Kennedy. Dated April 10th. A storage or secondary battery is provided in multiple arc with the lamps, and a dynamo is driven from the car axle, and the parts are constructed and the circuits arranged in such a manner that the current passes into and through the secondary battery for energising the same, or directly through the lights, or both, and when the car is standing still or running below the minimum speed, an electro-magnet in the circuit is provided for acting upon a switch in such a manner as to break the main circuit passing through the secondary battery from the field magnets and armature, and throw in a resistance to prevent the current equalising through the dynamo, and an automatic three-point switch is made use of, so as to give the same direction to the current in passing through the battery, whether the car is running in one direction or in the other direction. 9 claims.

19,127. "A new and improved process for the production of ozone." J. T. Donovan and H. L. Gardner. Dated October 9th. Claims:—1. The process of generating ozone, which consists in submitting to electrolytic action a solution of a permanganate of a solid metallic base in water, substantially as and for the purposes described. 2. The process of generating ozone, which consists in submitting to electrolytic action a solution of potassium permanganate in water, substantially as and for the purpose described.

22,453. "Improvements in the manufacture of insulated electric conductors, and in the method of, and apparatus for, producing the same." J. Robinson. Dated November 20th. Consists of the method of applying to an insulated wire while in a moist or wet state fibrous material, such as cotton or the like, applying a cord or thread thereto, and subjecting the covered and corded wire to an insulating bath, and thoroughly saturating the same therewith to produce an insulated electric conductor. Further consists of the method of making an electric conductor by continuously drawing a rotated wire through a bath of insulating material, and while still moist applying and compacting fibrous material thereto, then cording the insulated and covered wire, and laying up the same for subsequent treatment or use; and, further, consists of apparatus for the conduct of the method of making an electric conductor.